THIRTY-SEVENTH ANNUAL REPORT

For the calendar year 1947

- Northern -
Rocky Mountain
Forest & Range
Experiment Station

Missoula Montana

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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

Contents

INTRODUCTION

Accomplishments of the Northern Rocky Mountain Forest & Range Experiment Station during 1947, together with plans for the current year, are presented in the text of this 37th annual report. The reader may better gage the significance of accomplishments and the appropriateness of plans by an account of recent regional developments and trends.

Complete statistics for 1947 are not available but in 1946, 264 new sawmills in the region represented an increase of 59 percent over the previous year. Overall 1946 lumber production at 1,227 M feet was up 12 percent over 1945, 34 percent over 1935. Tie production fell off 26 percent, reflecting a price-stimulated shift to production of rough green lumber, but indications are that in 1947 tie production pulled out of the slump. A 1946 surge in house construction was responsible for an 82 percent increase in shingle production.

The cutting of timber for poles is on the increase, 65 percent greater than during the prewar period. There are now 5 pressure and 24 non-pressure treating plants representing an investment of $5,000,000. Approximately 5,000 persons are employed. Almost the entire increase in pole production is based on lodgepole pine and western larch, species which hitherto contributed little to the pole or other wood-using industries. In 1946 lodgepole pine alone accounted for nearly half of the total pole output, whereas 10 years ago the volume of this species was less than 2 percent of the total. Western redcedar has been the leader. Montana emerged as the leading producing state in the region -- 300,000 lodgepole and larch poles valued at over two million dollars.

A new market has developed in the Lake States for eastern Montana pulpwood. Some 25,000 cords of lodgepole pine were shipped in 1946. Last year was marked by further effort to increase production and to press for longer term sales of national forest timber. Other developments in the pulpwood field include continuing effort to finance a pulp mill in western Montana and the possibility of a new plant being installed in North Idaho.

Christmas tree production in Montana totaled 2½ million trees in 1947. This represented a drop of about 24 percent from the 1946 level, attributable to discoloration and defoliation of many Douglas-fir trees and to a shortage of personnel to administer public sales. Nevertheless Montana trees were distributed to 31 states from New York to Texas and California. Their value FOB cars is estimated at $760,000.

More timber is being cut from the national forests than ever before. At 395 million feet the 1947 cut was up 26 percent from the previous

year, and up 150 percent from the 1940 level. Even more significant is the spectacular increase in utilization of lodgepole and the so-called mixed species, principally larch, Douglas-fir, and true firs. In 1940, 57 million feet of these species were cut, whereas 1947 production totaled 266 million feet, an increase of 367 percent. Meanwhile pine, both white and ponderosa, experienced a 30 percent increase.

The trend of resource use is up but the trend of resource growing stock is down. This is to be expected in the development of virgin timber country. But it is disturbing to note the discrepancy between proportion of cut by species and the proportion of stand volume by species. The cut of white pine, for example, greatly exceeds the allowable cut of that species under sustained yield. To a lesser extent the same is true of ponderosa pine, but there is room for liberal expansion of the cut of other species, which in the aggregate make up 70 percent of the total sawtimber volume. Furthermore, an important reversion of timber types is taking place. This is illustrated by a comparison of 1933 vs. 1944 forest survey statistics for Benewah County, Idaho, which show that the area occupied by western white and ponderosa pine types decreased 178,000 acres or 67 percent in the 11-year period, while the acreage of other less valuable types increased.

The white pine blister rust is, of course, still with us. Expenditures made for control amount to plus or minus a million dollars annually during the last 12 years. The job is turning out to be much bigger than originally supposed. Both critics and sympathizers and, in fact, administrators of the program have questioned the efficacy of what we are doing. They have called for an appraisal of accomplishments to date and development of a policy to govern future work on the national forests.

The region is now concerned with another killer of white pine. It is called [the] "pole blight." Neither the cause nor the control is yet understood, but ravages in pole sized timber are reaching serious proportions.

These are some of the regional developments and trends which have a bearing on the research program of the station. The spectacular increase in utilization of species which before the war could scarcely be given away thrust new problems upon administrators as well as research, which up to that time had devoted major effort to white pine management studies. But white pine management itself was due for revolutionary change because of blister rust, hence the major projects in that field despite many years of previous work. The cost of growing white pine under the handicap of blister rust and the need for a policy to govern future control operations on the national forests were fit subjects for the Division of Forest Economics to consider. Its analysis and report, prepared jointly

with the National Forest Division of Timber Management, was a major project in 1947. Of course, increased sale activity and attendant need of timber management planning spell increased dependence on forest survey information - a responsibility which is ever harder to redeem because of financial limitations and inability to produce reliable estimates for small areas.

Forest Utilization Service activities have been stimulated by the larger production, and they have in turn served to guide it and assist with problems encountered by new operators of untried timber.

Not mentioned but implicit in the accelerated timber use program is the need to get ahead with fire control planning or engineering research. Fire control planning and strategy in the northern region are based on research conducted before the war. Great changes have occurred in fuel types and stand values since then. Roads are more numerous, better equipment is available, and aircraft are being used for detection and for delivery of men and supplies to going fires. This year fire control planning research made a start towards regaining the lead it lost because of greatly curtailed activity during the war.

Significant developments in the livestock section of Montana are also noted. During the period 1940-1946 total human population in Montana fell off 12,000 persons or 2.1 percent. All except five of the 35 Northern Great Plains counties either remained stationary or experienced losses up to 24 percent. The few increases were significanctly in the "big town" counties. This is a reflection of war interruptions - also of poor land use, and a trend toward larger ranch units.

Montana ranges have responded well to the last several years favorable for drouth recovery. About 25 percent is still obviously below par from a range viewpoint; criteria for judging watershed aspects are inadequate. But the remainder is apparently in good condition.

Sheep numbers at 1.9 million are down 51 percent from the 1942 peak of 3.9 million. There has been a steady decline in number of horses which total only 173,000 now in contrast to 450,000 in 1930. On the other hand, cattle numbers at 1.8 million are near the all-time peak reached in January 1945. They number twice as many as in 1938. Feed reserves are at a rather low ebb, except where the current winter has been very open. A drouth next season could have very bad repercussions.

A sharp increase in Montana wheat acreage has resulted in replowing of some fields that have not been cropped for years and the breaking up of native range as well as many reseeded fields. The 1948

estimate is for 4 million acres of wheat, up from 3.7 million in 1945 and 2.2 million acres in 1936. If drouth comes soon, straight grain farmers are due for hard times and the acreage needing reseeding will be enormous, probably totaling 3 million acres in Montana alone. The station's reseeding research program reflects this need, but should be strengthened. Plans for the coming year also provide for work on the nutritional value of range forage plants, and development of criteria for judging range trends and conditions.

There is urgent need to integrate forest and range management planning with plans for physical improvements proposed and building in the Missouri and Columbia River Basins. Forest lands of the northern region supply 85 percent of the water in the Clarks Fork of the Columbia measured at Heron, and three fourths of the water in the Missouri River at Fort Benton. Watershed management is of utmost importance to the quantity, quality and seasonal flow of these waters, and to the permanence and effectiveness of dams, power and irrigation developments, and other downstream installations and values. Forest influences research is not being performed in this region, incongruous as it is. It is expected that the coming year will see a start on the inauguration of flood control surveys on forest land in the Missouri River drainage.

DIVISION OF FOREST MANAGEMENT

A. Accomplishments in 1947

North Idaho Branch Station

1. Cutting practices in the white pine type were reviewed and studied. Early in the year, marking instructions for this type prepared in 1946 were again revised and put in final form for inclusion as a section in the Region One Timber Management Handbook. Although written in Forest Service manual style, the instructions are applicable to western white pine stands of any ownership where white pine is to be grown and protected from blister rust. The instructions have been distributed to public forestry agencies and to private timberland owners. They include 4 pages of condensed basic information on the silvics of white pine, 3 pages on blister rust and insect control, and a statement on silvicultural objectives. The marking instructions proper cover five pages. The stands are classified by age, vigor, quality of associated species, and the probabilities of ribes being a serious problem. Cutting practices, slash disposal, and regeneration measures vary for the different classifications. The summary page from the marking rules appears on page 6. The material presented in the instructions contains much information obtained from National Forest Administration, the Office of Blister Rust Control, and the Forest Insects Laboratory, as well as original station work.

The Station has continued to aid National Forest Administration in reviewing and determining cutting practices on the ground. The station and representatives from the Regional Office of Timber Management, National Forests, Forest Insects Laboratory, and the Office of Blister Rust Control examined cuttings which are being treated according to the new instructions on the Coeur d'Alene and Clearwater National Forests. Prospective sale areas also were examined and cutting practices recommended on the Coeur d'Alene and Kaniksu National Forests. Cutting practices in the western white pine type are undergoing a radical change because of blister rust control requirements and a realignment of management objectives. Hence, a cooperative approach by all interested agencies seems the best method of working out and getting new methods into practice.

During July, a 2-day field meeting was held at Deception Creek for foresters from state and private organizations to explain the new white pine marking rules and to show some of the experimental work upon which they are based.

CONDENSED TABLE OF MARKING INSTRUCTIONS

(Page 14 of western white pine marking instructions, Revised 1947)

Stand description						Cutting practices			
Age class	Ribes potential	Vigor	Condition of mixed	Stand class	Page	Method of cutting	Maximum volume to remove in first cutting	Slash disposal	Broadcast burning practice	Regeneration
Immature (A)				A	8	Light partial	25% of basal area	Lop and scatter. Pile and burn concentrations	None	Natural
Mature (B)	Light	Good (1)	(a)	B 1a	9	Partial	40% white pine 50% all species	Lop and scatter. Pile and burn concentrations	None	Natural
						Seed tree	90%	Pile and burn.	None	Natural
		Poor	Sound (b)	B 1b	9	Clear-cut	100%	Broadcast.	Single or double	Planting
			Defective (c)	B 1c	10	Clear-cut	100%	Broadcast.	Single or double	Planting
	Heavy	Good	Sound (a)	B 2a	10	Partial	40% white pine 50% all species	Lop and scatter. Pile and burn concentrations.	None	Natural
	(2)		Defective (b)	B 2b	10	Partial	40% white pine 50% all species	Lop and scatter. Pile and burn concentrations. Finally broadcast.	Single or double	Planting
		Poor	Sound (c)	B 2c	11	Clear-cut	100%	Broadcast	Single	Planting
			Defective (d)	B 2d	11	Clear-cut	100%	Broadcast	Single or double	Planting
Over-mature (C)				C	11	Partial or clear-cut	100%	Lop and scatter. Pile and burn. Finally broadcast.	Single or double	Planting
Uneven-aged (D)				D	11	Very light partial		Lop and scatter. Pile and burn concentrations.	None	Natural

2. The Station assisted in reopening investigation of a serious unidentified disease of western white pine - pole blight - in cooperation with the University of Idaho. Pole blight has been determined to be a very serious threat to western white pine. It kills young trees in the 40 to 100-year age classes, which are the scarcest age classes in the western white pine type. Hence, the disease is further restricting the growth in age classes that are critical to future management.

Prior to 1947, the disease had no established descriptive name. The Station proposed "pole blight" and this name seems to have been accepted generally.

The Station, in cooperation with National Forest Administration, made a survey of the extent of the disease during 1947. It was found within five national forests and in privately-owned stands adjacent to four of these forests. It is believed to be present in 70,000 acres of young western white pine timber.

The Station installed a small experiment to test the possibility that pole blight, like the little leaf disease of southern pine, can be ameliorated by application of fertilizers. At the suggestion of Dr. Hepting of the Division of Forest Pathology, ammonium sulphate and Vigoro were applied at two levels of application to the soil surrounding diseased trees.

Dr. D. S. Welch, who was employed by the University of Idaho under a research grant, made Deception Creek Experimental Forest his summer headquarters for a search for the causal agent of pole blight and for diagnostic characteristics of the disease. The Station appointed Dr. Welch a collaborator and provided him with living, office, and travel facilities, and tools. The Station also assisted Dr. Welch in becoming familiar with the disease over much of its range. Dr. Welch has inoculated a number of trees near the Station with organisms found in cultured material to determine if any may be the causal agent. He also has described the characteristics of the disease more accurately than had been done previously. He is preparing a report on his work.

The Station prepared a pamphlet, "Pole Blight - A New Disease of Western White Pine," which describes in simple terms what is known about the disease, its potentialities for harm, and the need for further pathological research.

3. A beginning was made in determining the growth of older plantations. Some of the older plantations on burns in the western white pine type have grown remarkably well. Five plots were established in 23-year-old white pine plantations on the Coeur d'Alene National Forest and five in 29-year-old white pine plantations on the Cabinet National Forest in order to learn of the development and yields

from artificially regenerated stands.

Site determinations for these plantations, made by the conventional height-over-age method, gave absurdly high site indices in comparison with the western white pine normal yield tables. When site was estimated upon the basis of experience, the following comparisons of the plantations with well-stocked natural stands were found:

Number of trees - - - -	29 percent of normal
Basal area - - - - - -	135 percent of normal
Cubic volume - - - - -	170 percent of normal
Average d.b.h. - - - - -	209 percent of normal

4. Harvest cutting experiments in western white pine were continued. Fifty plots, each one-fifth acre in area, established during 1946 in advance of partial cutting in the Steamboat Creek drainage of the Coeur d'Alene National Forest, were remeasured after cutting. A five-year remeasurement was made of two plots testing partial cutting in a 180-year-old stand on a south slope in the Deception Creek Experimental Forest. Five-year remeasurements were also made on 17 plots testing partial cutting in immature stands.

A preliminary report based upon these studies will be prepared during 1948.

Additional tests are needed to cover wider ranges of age classes and intensities of cutting. A reconnaissance was made in 1947 of three areas in the Clearwater National Forest to determine their suitability for such tests. Study plots will be established in one of these areas during 1948.

In connection with the harvest cutting project, an experiment to test killing of defective hemlock by poisoning with sodium arsenite was started. The experiment includes 108 trees. One-third, or thirty-six, of the trees were poisoned in July, another third in November, and the remainder will be poisoned in May, 1948. Other variables in the test include concentration of the poison (10 and 40 percent), the size classes of trees (7 to 12, 13 to 18, and 19 to 24 inches), method of introducing the poison (poison axe and auger holes), and spacing of holes (poisoning axe holes at 4, 8, and 12 inch intervals, and auger holes at 8, 16, and 24 inch intervals). Initial results from the July poisoning are encouraging, but one curious reaction has been observed. The dying of all but a few branches was rather common. Surviving branches are most common where crown competition was the greatest. It rather suggests that portions of the tree where physiological activity is very low do not take up enough poison to cause killing.

Ammonium sulfamate was also tested as a poison in a preliminary experiment. Forty western hemlock trees were poisoned with this

chemical in November using two concentrations of water solution.

5. New stand improvement work was limited to one new plot to test weeding to free white pine from western larch, and ten small pruning plots in white pine plantations. The experiments supplement existing tests. The weeding test showed that freeing white pine from western larch of large sapling size required from one to two man-days per acre. Plantation white pine trees were pruned to a full log length at the rate of 40-50 trees per man day.

6. Information was provided for the special study to determine blister rust control policy. The most important contribution to this study was the preparation of an empirical yield table for prediction of growth of stands of different stocking classes and ages under two levels of management. In addition, information and advice were given on other phases throughout the year.

Western Montana Work Center

7. A study of an early ponderosa pine selective cutting in the Bitterroot National Forest showed that where stand conditions permitted light cutting, more growth resulted. The net growth for 35 years that was found by reserve volume classes is shown below:

Volume per acre in residual stand (Bd. ft.)	Net growth per acre in 35 years (Bd. ft.)	Net growth in 35 years (Percent)
627	61	10
2,396	1,239	52
4,655	3,420	73
9,089	4,349	48

The heaviest reserve stand made the most net growth. However, the next-to-heaviest reserve stand produced three-fourths as much growth from half the growing stock, and on a percentage basis made the best showing. Analysis of the material by five-year periods following logging showed that the greatest growth occurred during the first 20 years following cutting in the two heavier reserve stands. Subsequently, growth has declined. It indicates that the time has been reached or passed when the second cutting should be made. The two lightest reserve stands, on the other hand, grew slowly at first but during the past ten years have picked up somewhat due to ingrowth.

Two field meetings were held in the study area. One group was composed of local people, mostly loggers and ranchers from the Bitterroot valley. The other group was composed of foresters, including two

retired forest officers who had participated in administration of the sale, and C. A. Pearson. Pearson expressed many worthwhile comments on the present condition of the stand, the desirability of a second cutting, and differences between this stand and those in which he has worked in the Southwest. He observed that diameter growth is faster in the Southwest and invasion of Douglas-fir is less of a problem there, but distribution of trees is better in Montana and there is much less lightning damage.

8. Cutover stands both in larch-Douglas-fir and ponderosa pine types were examined throughout western Montana in order to learn the silvicultural results of past cutting. A field party worked continuously from early May until late September, measuring and recording information on old cuttings. In all, 43 cuttings were examined and 185 plots were taken. Two-thirds of the plots were in larch-Douglas-fir type and the balance in ponderosa pine type. In most cuttings only a few plots were taken because the object was to get widespread sampling. However, one early Forest Service sale area in larch-Douglas-fir near Seeley Lake was made the object of a more detailed study similar to that conducted in ponderosa pine type on the Bitterroot National Forest in 1936.

Analysis of the data is well started. It is too soon to discuss final results, but some general observations can be reported. The usual practice in all these old cuttings was to cut larch more heavily than Douglas-fir because of larger size and better quality of the larch. Douglas-fir, which can endure more shade than larch, has regenerated more aggressively both before and after logging. In these ways, selective logging generally has had the effect of increasing the proportion of Douglas-fir, the less desirable of the two species in the larch-fir type. Western larch grows comparatively fast while young, but beyond the age of perhaps 150 years, it grows very slowly, although the tree is long lived. It is rather likely that a comparatively short rotation will be found most suitable for this species.

9. A start was made on investigating cultural methods for growth of Christmas trees. Christmas tree cutting annually brings about one million dollars into western Montana. It seems unlikely that this business which helps to prolong the employment season for many workers can continue indefinitely unless management practices are introduced. Some farmers, Christmas tree producers, and state and national forest officers have been experimenting for a decade or longer with simple cultural operations such as pruning, thinning, and "stump culture." Stump culture is the growing of a new crown from lower branches or an adventitious bud after removal of the upper portion of the crown.

The Station prepared a non-technical bulletin illustrated with reproductions of photographs to show how small second-growth Douglas-fir can be managed for repeated crops of Christmas trees. The booklet was compiled from information received from persons who have been

producing Christmas trees and by examining stands where Christmas trees have been cut. This material was collected over a period of several years but had not previously been reproduced for extensive distribution. Several experimental plots to test pruning, thinning, and stump culture were installed in young timber owned by a farmer who engages in Christmas tree production.

A Station member is serving as chairman of a committee that is considering several aspects of Christmas tree production, particularly in the field of marketing. Other members of the committee include representatives of Montana State University Forestry School, Soil Conservation Service, and State Forester, the Extension Forester, a Farm Forester, and one Christmas tree grower. Grading of trees has been made the subject of a special study by this group. There are neither established standards nor written specifications to completely describe trees acceptable to the trade. The committee, in cooperation with one of the larger buyers and shippers, measured various characteristics on 200 trees in the buyer's yard. A set of tentative grades has been developed from these measurements. It appears that trees can be accurately and quickly graded into quality classes by means of characteristics such as number of basal branches, crown-width ratio, number of perfect sides, stem diameter, and density of foliage. There is a rather high correlation between weight and quality. Further checking and conferences with producers and buyers will be needed before it can be decided how and if Christmas trees should be graded commercially.

10. A limited amount of help was given on forest influences problems. Numerous problems concerning forest influences are referred to the Station for answer or assistance. As this Station does not have a forest influences section, we have had to turn away many of these requests. However, during the past year we have assisted to a limited extent. Early in the year a working plan was reviewed for the Regional Office division of Land Use Coordination for a series of snow courses to measure the effect of forest cover on snow accumulation and melt. Data from some of these courses were later analyzed. During the spring, a severe flood occurred on the Bitterroot River. A trip was made to the headwaters of this river in company with national forest administrative officers to observe the damage and the conditions that may have contributed to the occurrence of the flood. In September, a trip was made to the Snow Laboratory maintained by the Army Engineers and the Weather Bureau on Flathead National Forest near Glacier Park in company with national forest administrative officers. The physical set up of the laboratory was examined and their work program reviewed and discussed. Laboratory personnel presented certain needs on which they would like help from the Forest Service and we in turn discussed some of our problems which their work can aid in solving. The need for a forest influences division at this Station is ever apparent.

11. A series of experimental harvest cuttings in ponderosa pine type were remeasured. The experiment which was started in 1932 includes three cutting methods: (1) commercial clear cutting to roughly a 14-inch diameter limit, (2) zero-margin economic selective logging, and (3) "silvicultural cutting" to leave a thrifty stand having desirable species composition. The volumes in the reserve stands immediately after cutting are shown below:

	Volume per acre (bd. ft.) in trees 10" d.b.h. and over	
	Ponderosa pine	Douglas-fir
Commercial clear cutting	817	1201
Economic selective logging	5730	4382
"Silvicultural cutting"	3306	821

During the first five years after logging, ponderosa pine suffered heavy mortality, chiefly from bark beetle attacks. The selective cutting sustained a net loss of 1500 board feet per acre, the commercial clear cutting 300 board feet per acre, and the "silvicultural cutting" less than 200 board feet. The plots are from 4 to 7 acres in size, large enough to give reasonably good samples.

The timber has recovered and grown rather well in the following 10 years. The most striking features of growth are the comparative gains made by Douglas-fir in the commercial clear cutting and the economic selective cutting. For the entire 15-year period, ponderosa pine has made little net gain in volume on these two plots; in fact, growth has not yet balanced the heavy initial mortality on the economic selective cutting. On the other hand, Douglas-fir has averaged about 35 to 55 board feet per acre growth annually. In contrast, on the "silvicultural cutting" despite the comparatively light reserve stand and some initial mortality from insect attacks, growth has averaged around 50 board feet per year, of which two-thirds is on ponderosa pine.

Other Parts of the Region

12. The results of past cutting practices, the literature and tentative proposals for cutting practices in lodgepole pine were summarized in a report. This report was distributed to national forest personnel in Region One. The report recommends that, in general, mature and overmature stands (over 120 to 140 years) be clear cut. However, it recognizes the practical problem that clear cutting may have to be performed in installments because many operators are not able to utilize trees of all sizes or conditions. It also recognizes that under certain conditions, selective cutting is silviculturally desirable. Exceptions include scenic and recreation areas, creek bottoms, and two-storied or somewhat all-aged stands.

Where clear cutting is practiced, it is recommended that cutting be limited to one-half the area in a drainage, with the clear cutting broken into blocks less than 50 acres in size in order to prevent excessive disturbance to the natural streamflow.

Dwarf mistletoe is considered to be a serious pest that probably can be controlled only by clear cutting before reproduction becomes established.

For slash disposal, piling and burning is suggested in high-hazard areas such as roadsides. Lopping of tops is believed adequate for most other places. Scattering of slash is advised where the lopped material is so concentrated that it will hinder reproduction on areas larger than 15 x 50 feet.

Use of sale area betterment funds is recommended for the following:

(a) Felling or poisoning of mistletoe-infected cull trees left after clearcutting, to prevent infection of reproduction.

(b) Planting of creek bottoms where clear cutting is necessary, and planting of south slopes in the event that natural reproduction fails, and

(c) Thinning, but only on a restricted and experimental basis until methods and results are better understood.

Several steps for prevention or reduction of erosion are suggested, including points to consider in location of roads, the manner of using the skid trails, provision for drainage on roads, and scattering waste material on skid trails.

Ten 1/10th-acre growth and reproduction plots were established on a partial cutting in the Gallatin National Forest. The Station took part in a marking conference on the Gallatin National Forest and a marking school for sales personnel from the Helena National Forest.

What is believed to be a record for dense stocking was observed in the Little Rockies near Zortman, Montana. Seven hundred and sixty-four lodgepole pine seedlings 9 to 10 years old were counted on a sample milacre quadrat in a 1936 burn (rate 764,000 per acre).

13. Prescribed burning operations on the Colville Indian Reservation were examined. Forest Supervisor Harold Weaver of the U. S. Indian Service has for several years been employing prescribed burning partly to destroy accumulations of dead wood that are a serious fire hazard and partly to thin dense patches of reproduction in ponderosa pine type.

A week was spent in company with Colville Reservation forestry personnel examining some of the results. The work has been performed at remarkably low costs. One day was spent assisting Indian Service officers in making a systematic survey of a five-year-old prescribed burn in an all-aged mature stand to determine the effect on stocking of reproduction. One hundred and fourteen plots 1/250th-acre in size were examined. The principal results of burning are shown below.

	Before fire	After fire	5 years later
Percent of plots stocked with ponderosa pine	75	49	85
Percent of plots stocked with Douglas-fir	11	1	5
Number of ponderosa pine trees per acre	1647	421	939
Number of Douglas-fir trees per acre	37	2	15
Average height of ponderosa pine on plot (ft.) 1/	15.6	18.9	9.2
Average height of Douglas-fir on plot (ft.) 1/	13.8	0.5	0.5

1/ Trees over 32 feet tall are not included in these figures

It is evident that the fire reduced density of the reproduction greatly. Douglas-fir and the smaller pine experienced the greatest losses. Regeneration following the fire has improved distribution of stocking and increased density. The breaking up of dense thickets appears to have been decidedly beneficial. The possibility of damage that might be caused by an uncontrolled fire during bad burning conditions has been substantially lessened by the destruction of pitchy snags and windfalls in the prescribed burning. The method appears to have considerable merit.

B. Plans for 1943

North Idaho Branch Station

1. A guide for stand improvement work will be prepared. The guide is a high-priority need of timber sales personnel on national forests for their use in stand improvement following timber sales operations. The first draft will be written in a form primarily for use on national forest timber sales. After completing this report, if a different type of presentation seems necessary, another report covering much the same material but using different presentation style will be drawn up for farm woodland stand improvement practices.

2. Study of pole blight will be continued in cooperation with the University of Idaho. The Station's efforts will deal chiefly with aspects

where specialized pathological training is not required. These include determining geographic distribution of the disease, observing intensification of the disease, recording disease development in individual trees, and taking observations on the trees fertilized in 1947. In addition, the Station will give assistance and use of facilities to pathologists from the University of Idaho and, if requested, make periodic observations on the University's artificially inoculated trees near Deception Creek headquarters.

3. A progress report on results of partial cutting in western white pine will be prepared. This will be a preliminary report chiefly based upon the first five-year measurement. It will summarize growth, mortality, and the reaction of individual trees in relation to outward appearance of thrift.

4. Studies of methods of stratifying and hastening germination of white pine seeds will be initiated. This investigation is an outgrowth of an expression of interest by both private and public foresters in further work on the direct seeding project.

Virgil Moss, Office of Blister Rust Control, has developed a machine for cracking the seed coats of white pine seed which he reports hastens germination. Some of the seeds that the Station will work with will be cracked with Moss' machine in advance of stratification. The object is to get germination immediately after field sowing in order to shorten the period when the seeds are subject to destruction by rodents. Part of the seeds will be sown on a burn in the neighborhood of the Priest River Experimental Forest and part of them will be sown in Savenac Nursery. The latter test is for the purpose of determining if the methods of hastening germination have utility in nursery practice.

5. Preliminary plans will be made for studies of two critical problems in management of the white pine type. (a) Objectives and methods of managing lands of the white pine type outside of blister rust control areas. (b) Rehabilitation and management of cutover areas on national forest, state, and private lands supporting a residual stand of mixed species, frequently defective or of poor vigor, and intermingled with young growth of various species and sizes. Attention will be given to the magnitude of these problems and their possible solution through research.

6. Cooperation to the extent possible will be given to state and private agencies. A preliminary discussion has been held with the University of Idaho School of Forestry concerning cooperative studies on their school forest. It will be looked into further during the coming year.

Potlatch Forests Incorporated has expressed interest in establishing an experimental forest in the Clearwater region of north Idaho and has indicated a possibility of furnishing the land. The Station is

very anxious to expand its research program in the Clearwater district in order to study white pine on its best sites. However, until such time as the two existing experimental forests in northern Idaho can be developed fully, it seems inadvisable to assume obligations for a third experimental forest. At present, the Station is not able to make full use of either Priest River or Deception Creek Experimental Forests.

Western Montana Work Center

7. Analysis and reporting of the information collected in the cut-over area surveys will be completed if possible. There is a very large amount of computing work involved in this task but it is believed that by giving this job high priority it can be completed and written up.

8. A plan will be made for a comprehensive series of experimental tests of Christmas tree culture operations and field work will be initiated. This plan will be made in cooperation with several forestry agencies and one or more producers. Production costs for growing Christmas trees will be considered in connection with the silvicultural tests. The grading studies will be continued.

9. Review of literature on ponderosa pine and larch-Douglas-fir types will be continued and an attempt will be made to complete a problem analysis for western Montana.

10. Considerable attention will be given to deciding upon choice of an experimental forest for operation as a managed unit. There are two formally established experimental forests within national forests in western Montana. Montana State University School of Forestry also has an experimental forest. None of these three has been used to any extent.

11. Harvest cutting experiments in ponderosa pine and larch-Douglas-fir stands will be initiated. This is the logical step following completion of the study of cut-over stands. The most promising lead for a specific project is a second cutting in the early selection cutting in Lick Creek on the Bitterroot National Forest. The Forest Supervisor has expressed interest in promoting a second cutting in this stand which was first cut almost 40 years ago.

The Station's analysis indicates that parts of the stand have been ready for a second cut for at least 10 or 15 years. It will not be possible to re-cut the entire area because considerable parts were cut heavily the first time. The second cutting should be valuable, both as laboratory material for future measurements and as a local demonstration of good forest practice.

Opportunities for cutting experiments in mature ponderosa pine and larch-fir stands will be searched for in other localities on a cooperative basis with both public and private organizations.

12. Third five-year remeasurements will be made of experimental thinning in young ponderosa pine. A series of nine plots were established in 1933 to test the effect of different intensities of thinning in 40- to 50-year-old ponderosa pine stands. Remeasurement of these plots will give results of fifteen years growth since thinning.

13. Plans are being made to install a series of growth plots in selective cuttings in cooperation with the Montana State University Forestry School. These plots will be located in selective cuttings principally in ponderosa pine on J. Neils Lumber Company and National Forest lands near Marland, Montana. The plots will be established as a part of the program for the spring camp for senior students.

14. Assistance will be given to the Station's Fish & Wildlife Service cooperator in establishing an experiment to test the effect of artificially simulated browsing upon small ponderosa pine trees. The purpose of the study is to give a basis for estimating the injurious effect of deer browsing upon ponderosa pine reproduction. Such browsing is common in places and apparently decidedly harmful to the trees, but without experimental evidence it is difficult to appraise the significance in terms of mortality or reduced growth. Assistance will also be given to the biologist in analyzing a survey of deer damage made in an area of high concentration on the Kootenai National Forest.

DIVISION OF FOREST ECONOMICS

A. Accomplishments in 1947

Forest Resources

1. Expansion of forest industries, planning for use of water resources in power and irrigation projects, concern over land use problems in the Missouri and Columbia valleys and emphasis on intensifying forestry all stressed the importance of and the need for more information about forest resources. The work program of the Division of Forest Economics in the past year was directed toward meeting this need. The principal effort has been the continuation of the Forest Survey --collecting, compiling, analyzing, and disseminating basic forest resource information in the Northern Rocky Mountain Region.

   With over 25 million acres of commercial forest land in the region, much of which is undeveloped, the opportunities for new industrial developments are many. Yet, if such developments are to be sound and the growing of timber is to be effectively coordinated with other land uses, much more needs to be known as to the extent, location, kind, volume, and relative accessibility of the present timber supply. Because of financial limitations the forest survey is providing data which are largely useful only in regional and state development; it does not fill the local needs of counties, and interests of existing and prospective industries. Much of the survey data is 15 years old and now of only limited use because of the heavy cutting which took place during the war years.

   As more and more information becomes available from research in forest management --how to cut white pine to facilitate control of blister rust, how to cut lodgepole pine so as to maintain maximum water control, how to encourage natural reproduction of desired species-- the question of economic limitations becomes foremost. Almost no work has yet been done in this field, but the need is growing.

   Other problems, primarily economic in scope, which should be considered are: desirable adjustments in the land ownership pattern to facilitate intensive forest and farm management; what lands should be utilized primarily for forestry, for grazing, and for intensive agriculture; how light a partial cut is financially possible; the financial aspects of maintaining some areas primarily for growing Christmas trees; and marketing phases of handling the products from small ownerships. Without the answers to many of these questions the forests of this region will not be managed so as to contribute their maximum to the regional and national economy.

Forest Survey - Inventory

2. Two field inventory projects scheduled for 1947 were: a continuation of the initial survey in eastern Montana and a resurvey of the forest resources in Northeast Washington and North Idaho. Field work on these projects started in April, but by the end of May indications of appropriation cuts for Fiscal Year 1948 made it necessary to discontinue work in eastern Montana. Trained field crews were released and the staff of the division reduced from 14 to 3. In August sufficient funds were appropriated to continue this work, but by the time new field crews were hired and trained, most of the effective field season was lost.

In eastern Montana of 11 million acres of forest land to be inventoried, three million acres were covered by the end of 1947. This was two million acres less than was scheduled. Compilation of field data started in October.

In the resurvey, field work was completed in five Northeast Washington counties and one in North Idaho. For the Washington area 2.6 million acres of forest land were covered to complete the resurvey of four million acres in that state. In North Idaho 1.6 million acres of forest land in Boundary and Bonner Counties were inventoried. Approximately 8.5 million acres remain to be covered in Idaho during 1948 and 1949. Progress in the resurvey is in accordance with the 10-year program to complete a resurvey of the forests in the Inland Empire by 1956.

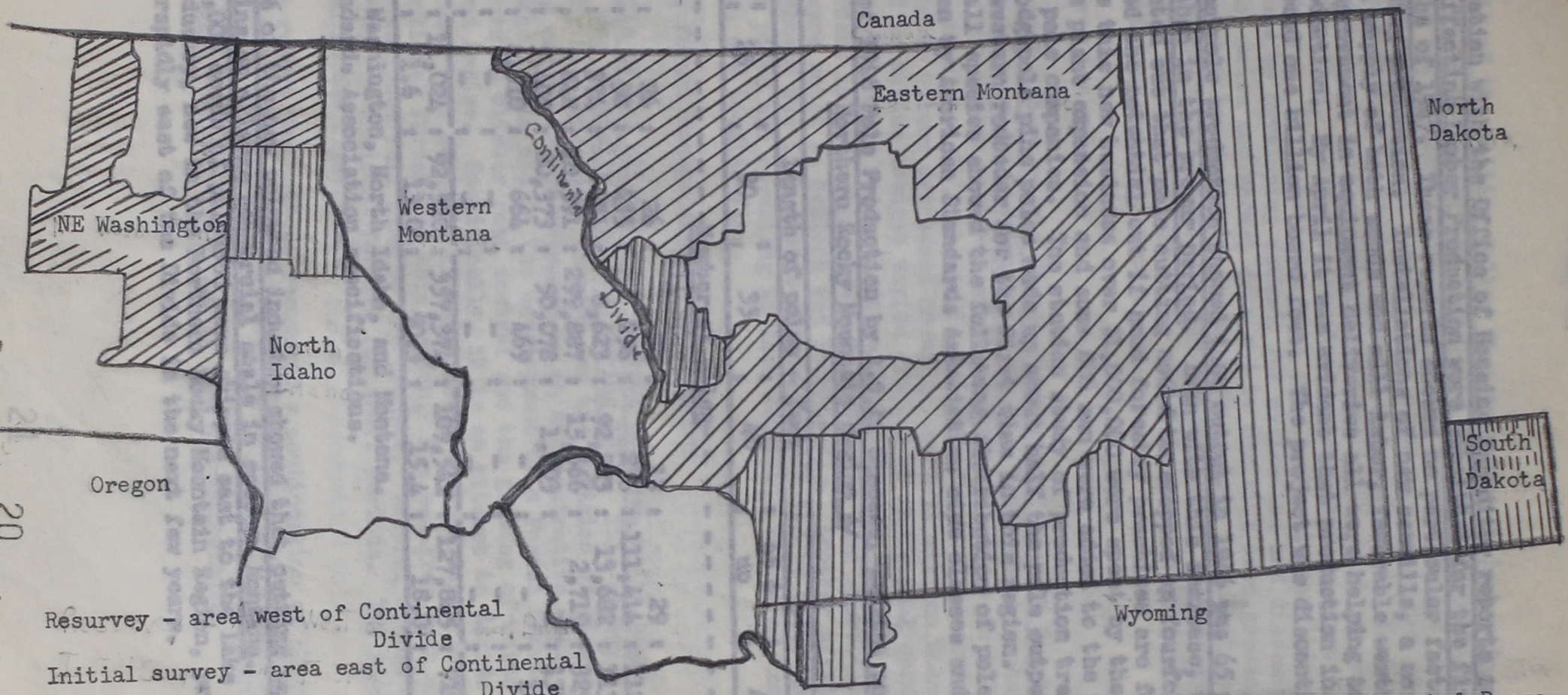
Forest Industry Analysis

3. The 1946 census of lumber, lath, and shingle production was carried on in cooperation with the Bureau of the Census. This census revealed two significant trends: that the number of sawmills had increased nearly 60 percent since 1945, and that lumber production had increased 12 percent. These relationships by subunits within the region were as follows:

State	Active Sawmills % Increase	Lumber Production % Increase
Montana	+ 60	+ 22
North Idaho	+ 59	+ 3
Northeast Washington	+ 58	+ 29
Region	+ 59	+ 12

FOREST SURVEY FIELD INVENTORY WORK

Accomplishments in 1947 and Plans for 1948
Northern Rocky Mountain Region



Resurvey - area west of Continental Divide

Initial survey - area east of Continental Divide

Legend

Area surveyed during 1947

Area planned for survey during 1948

Northern Rocky Mountain Forest & Range Experiment Station
Division of Forest Economics

4. In cooperation with the Office of Housing Expeditor reports on Factors Affecting Lumber Production were submitted for the first four months of 1947. These reports showed no particular factor as retarding production. Installations of new sawmills, a more plentiful supply of both woods and mill labor, favorable weather, and an improvement in equipment deliveries all were helping to boost production. By April it was evident that production in 1947 would exceed one billion board feet. The project was discontinued in May.

5. A study on pole production showed that output in 1946 was 65 percent greater than in the prewar period. Even with this increase, the report pointed out that pole cutting could be stepped up fourfold and not exceed the potential cut if good forestry practices are followed. To handle this new business over $1,000,000 were spent by the industry in plant expansion and some 800 men were added to the pay rolls of pole companies. The station study of production trends showed lodgepole pine poles made up about half the pole output, exceeding western redcedar for the first time in this region. A summary of all species showed the following distribution of pole production by American Standards Association size classes and lengths.

Distribution of 1946 Pole Production by A.S.A. Classes, Length, and Species
Northern Rocky Mountain Region 1/

ASA 2/ classes	Length of poles - feet: 20 & less	25	30	35	40	45 & up	All	Percent of total
	Number of poles							Percent
	All Species							
3	-	26	26	21	13	29	115	-
4	-	58	435	296	236	111,414	112,439	15.8
5	-	374	431	6,623	92,223	13,682	113,333	16.0
6	-	848	10,591	299,887	15,666	2,719	329,711	46.4
7	-	5,408	80,373	50,078	1,403	1	137,263	19.3
8	10,838	4,310	664	469	-	-	16,281	2.3
9	831	-	-	-	-	-	831	.1
10	488	-	-	-	-	-	488	.1
Total	12,157	11,024	92,520	357,374	109,541	127,845	710,461	-
Percent	1.7	1.6	13.0	50.3	15.4	18.0	-	100.0

1/ Northeastern Washington, North Idaho, and Montana.
2/ American Standards Association specifications.

6. A resumé of the new pulpwood industry showed that cutting was developing on a large commercial scale in eastern Montana. In 1947 over 25,000 cords of pulpwood were shipped east to the Lake States. This industry, new in the Northern Rocky Mountain Region, promises to expand rapidly east of the Divide in the next few years.

7. An analysis of the million dollar Christmas tree industry in western Montana indicated the importance of marketing problems. Research Note No. 50 showed that 3.3 million trees were cut in 1946, the highest production on record. But with this expansion it is evident that marketing problems are being accentuated. Lack of up-to-date and reliable market information in the past has resulted in overproduction, violent price fluctuations, and frequent "stop buying" orders. It is believed that such a chaotic condition can be minimized by developing methods for collecting and disseminating production, price and market data and by deriving tree grades. In addition, a problem analysis showed that certain technical phases of the Christmas tree business, such as methods of storage and shipping and an appraisal of costs and anticipated returns from various cultural methods, need study.

Forest Resource Analysis

8. A statistical report on the forest resources of Benewah County, Idaho was released as Station Paper No. 6. This report emphasized trends in the forest resource since the initial survey in 1933. The resurvey, completed in 1944, indicated that in the intervening period the sawtimber volume decreased annually about 37 million board feet. The trend in volume changes varied greatly by individual species, but most outstanding was a decrease of 66 percent in white pine and of 33 percent in ponderosa pine. On the other hand appreciable increases were noted in hemlock and Douglas-fir. Another significant fact disclosed was that stands formerly dominated by white and ponderosa pines are reverting to less desirable stands of hemlock, grand fir, and Douglas-fir.

Economics of Forest Management and Utilization

9. An analysis of the blister rust control problem, which began late in 1946, was virtually completed during 1947. This study, a joint venture by the Experiment Station and the Division of Timber Management, was undertaken in response to an administrative need. Broadly, its purpose was to aid in the development of a Forest Service policy with regard to blister rust control and the growing of white pine in the Inland Empire. Specifically, it is an attempt to decide how much blister rust control, if any, should be undertaken in the future on the national forests of this region. One man from each organization was assigned full time to the project. Several others were detailed from the national forests for short periods. The report is completed in the first draft.

In their report the authors recommend a continuation of blister rust control work. They suggest that the Forest Service launch an aggressive campaign to grow continuous crops of white pine in quantities in keeping with regional and national timber requirements.

The authors point out, however, that blister rust control will be a marginal investment unless it is accompanied by much more aggressive management, including planting, controlled burning, weeding and such other measures as are required to result in maximum timber yields. Control by present methods is expensive per acre and will be economical only if the white pine yields are fairly large.

A review of the history of blister rust control emphasizes that the project has labored under a number of handicaps such as violent fluctuations in funds and an unstable labor supply. It is apparent that if blister rust control is going to be worthwhile a determined effort must be made to increase the operating efficiency in every way possible.

To a large extent the degree of success of future blister rust control will depend upon research in methods of ribes eradication and white pine silviculture. Research by the Office of Blister Rust Control is particularly important because it may lead to new methods and techniques which will reduce costs and manpower requirements. The authors point out that present hand-pulling methods are slow, inefficient, and expensive, and cannot be tolerated any longer than necessary. Recent research in the field of hormone sprays gives hope of something better --eradication of all species of currant and gooseberry bushes by mechanized spray methods.

B. Plans for 1948

Forest Survey - Inventory

1. In eastern Montana the work plan is to complete field work on about five million acres of forest land. The work is to be concentrated largely in the southern tier of counties. Compilation of the field data for 19 counties across the northern tier will be completed.

For the maintenance survey, work will be continued in North Idaho in the following counties: Bonner, Kootenai, and Shoshone. Compilation of the data will be continued.

Forest Industry Analysis

2. Surveys of pole and pulpwood production for 1947 will be carried on as in 1946. The pole survey will be done in cooperation with the Rocky Mountain Pole and Treating Association. The special study of ways and means of determining fuelwood production will be continued.

The compilation and interpretation of Christmas tree data will be carried on in cooperation with the Western Montana Christmas Tree Association.

Forest Resource Analysis

3. Four reports on the status of the forest resources are scheduled — three primarily statistical and one analytical. The statistical reports will cover Northeast Washington, Northeast Montana, and Cascade County, Montana. The analytical report will be for western Montana.

Economics of Forest Management and Utilization

4. Plans are to have the report on the economics of blister rust control extensively reviewed and published in 1948. This will terminate the study.

5. A program of studies in the field of economics of forest management will be considered. Tentatively during 1948, it is planned to start an analysis of the cost and returns from various methods of growing Christmas trees in natural stands. Another project may be to collect basic information on logging to use in analyzing the returns and limitations under certain conditions. Such material will be of use in evaluating the economic possibilities of various silvicultural practices.

FOREST UTILIZATION SERVICE

A. Accomplishments in 1947

1. **Base for determining palatability and nutrient value of wood-sugar molasses and fodder yeast as livestock food was greatly broadened.** The interest that was shown at the start of the wood-sugar-molasses and fodder-yeast program has continued. As a result livestock feeding experiments are under way at the Montana Agricultural College at Bozeman, the Washington Agricultural College at Pullman, the Idaho Agricultural College at Moscow, and the Wyoming Agricultural College at Laramie. The enthusiasm shown by such qualified authorities in the stock-feeding field is especially gratifying and indicates the great potentialities the study holds for the West.

   Early results obtained at the Montana Agricultural College at Bozeman, where the first tests were started, show that silage to which 2, 4, and 10 percent of wood-sugar molasses was added was readily consumed by sheep, with no dislikes observed. At the Idaho Agricultural College wood-sugar molasses was found to be palatable to dairy cattle when mixed with silage.

2. **Plans for the construction of a mine-guide laminating plant have progressed during the year.** A mine guide is a timber that extends down the full length of the mine shaft and is used to guide the cage carrying men and supplies up and down the shaft. It is usually 5 by 9 inches in cross-section. Experimental laminated mine guides made from western larch were installed in a number of the Butte mines by the Anaconda Copper Mining Company some 3 years ago, and their continued successful performance has sufficiently assured the company of their value over guides made of solid wood. As a result the company has proceeded to order equipment for the establishment of a laminating plant at Bonner, Montana. It is conceivable that other mining companies in the region may follow the leadership taken by the Anaconda Copper Mining Company, since the problem of obtaining solid wood of the proper quality for this purpose is universally difficult.

   Present plans provide for the use of larch for all lamination. The practicability of using staypak as a facing material is now being explored because of its high abrasive resistance, a property considered desirable to protect the guides from damage caused largely by falling rocks. Preliminary work based on samples of larch selected at the Bonner mill of the Anaconda Copper Mining Company was recently completed by the Forest Products Laboratory. The results showed that larch when compressed to a density of 1.3 has three times the abrasive resistance and ten times the hardness of normal wood.

3. A study of the nonpressure pole-treating plants in the region was completed. At the request of the Rocky Mountain Pole and Treating Association, the Forest Products Laboratory, assisted by members of the local Forest Utilization Service unit, conducted a study of the results obtained in treating lodgepole pine, Douglas-fir, western larch, and western redcedar by the hot-and-cold-bath method. A total of 18 commercial pole-treating plants were visited and 64 hot-and-cold-bath treatments on the foregoing species observed. While the study showed that all the species concerned could be satisfactorily treated by the hot-and-cold-bath method, it focussed attention on the wide variety of results that were being obtained. It was apparent that considerably more study will be required if the number of nonconforming treatments is to be reduced.

Information developed from this study will form the basis for the new treating specification which the Rural Electrification Administration is planning to issue in cooperation with the pole association. Recent action placed butt-treated western larch back on the list of acceptable species for use by the REA cooperatives throughout the semiarid regions of the West.

4. Commercial and Laboratory pulping tests were made on insect-killed and green-cut lodgepole pine. Approximately 170 cords each of dead and green lodgepole pine were tested commercially by a pulp and paper firm in Wisconsin. The material came from a Forest Service pulpwood sale near White Sulphur Springs, Montana. Owing to the low moisture content of the dead wood (19.5 percent) in comparison to the green (41.9 percent), the chips from the dead wood did not pack as well in the digester. Consequently the yield per digester of dead wood was reduced 23.5 percent. Losses in other properties were less significant.

Similar tests were made at the Forest Products Laboratory on dead standing and down lodgepole and also on rapid- and slow-growing green-cut material. The samples, consisting of approximately one cord of each, came from Granite and Sanders Counties, Montana. The lot from Sanders County was cut from a 35-year-old stand. Results of the Laboratory tests showed a smaller loss in yield for the dead wood, approximately 44 percent of the dry weight of the wood, compared to 47 percent for the green. Most significant was the small loss found in the strength properties of the dead wood even where a relatively high percent of decay was present. Test material containing as much as 28 percent of advanced decay still possessed 88 percent of the bursting strength, 98 percent of tearing, 92 percent of tensile, and 97 percent of folding and endurance of that of green-cut material.

5. Inland Empire cottonwood was tested for the production of resin-impregnated plywood faces. Preliminary work in this field showed that the properties of many species were greatly improved when

the wood was impregnated with certain resins and compressed. Exploratory tests showed that cottonwood was especially well suited for this process because of the ease with which it could be impregnated and compressed. To get some measure on the performance of local species of cottonwood, six black and three narrowleaf cottonwood veneer logs were selected and sent to the Forest Products Laboratory for study. In order to improve the sampling the selections were made at St. Maries, Idaho, and Missoula and Livingston, Montana. In the first step of the investigation, which involved cutting the logs into veneer for impregnation purposes, it was determined that the logs contained a high percentage of gelatinous fibers. From one half to two thirds of the volume was so affected. This defect caused the veneers to cut roughly and buckle severely in drying, and consequently greatly reduced the value of the wood for the production of resin-impregnated plywood faces. When free of this defect the material proved very satisfactory. However, the percentage of suitable material was generally considered too small to make it an economic operation.

A report covering the study was prepared.

6. Interest in the fibreboard field points toward the establishment of a processing plant in the region. A strong interest in the construction of a local fibreboard-producing plant has been expressed by a number of experienced lumber manufacturers and merchandisers, upon reviewing the results of tests made at the Forest Products Laboratory on typical mill-waste material collected in this region by the local Forest Utilization Service unit. While final plans have not been drafted, the hardboard type of product is being favorably considered. The type of board to be produced may be determined largely by success of the development of a low-pressure-foraing press, a project now under consideration by one of the local engineering schools.

7. Strength tests on western larch transmission poles were completed. Strength tests conducted by the Forest Products Laboratory on green, pole-sized western larch were completed during the year. The test material was selected in Lincoln and Sanders Counties in Montana and Pend Oreille County in Washington. The strength values obtained were significantly higher than those previously developed for western larch. The earlier results were based on old-growth material. As a result of these test values, the pole committee of the American Standards Association has assigned western larch a working stress of 8,400 pounds p.s.i. This places western larch at the head of the list of American pole species in this respect.

8. Further study on the cutting of western larch veneer is under way. Eight representative western larch veneer logs were selected and sent to the Forest Products Laboratory for the purpose of develop-

ing more information on cutting temperatures and finishing characteristics of this species. The logs were selected in the Swan River drainage on the Flathead National Forest in Montana.

Other work involving western larch consisted in completion of the report covering the cutting by the Underwood Veneer Company of Wausau, Wisconsin. In addition to larch this study included western white pine, ponderosa pine, and Engelmann spruce.

9. Stem analysis shows benefits of good pruning in young ponderosa pine stands. The results of a milling study recently completed by the Forest Products Laboratory on a number of pruned ponderosa pine logs selected from a 35-year-old plantation established near the Savenac Nursery, Haugan, Montana, emphasize the value of early and careful pruning. Cross-sections through the knot whorls, some of which were pruned with an axe and others with a saw, show that a smooth, closely cut branch end heals over more quickly and with a lesser accumulation of pitch and dirt. The value of early pruning was brought out by the rapid rate at which pruning wounds heal if done before canopies close. A joint report on this subject will be prepared by Mr. Benson Paul of the Forest Products Laboratory and Mr. D. S. Olson, former chief of planting in Region One.

10. Lodgepole pine is now accepted by the Montana State Highway Department for the production of snow-fence lath. The local Forest Utilization Service unit, working through the Industrial Development Division of the State Chamber of Commerce, prevailed upon the Montana Highway Department to change its present snow-fence lath specifications to include lodgepole pine. This species was formerly regarded as too weak and too low in natural durability for this purpose. Information developed through various types of service tests conducted by the Northern Rocky Mountain Station on the performance of treated and untreated lodgepole has removed many of the early objections to the use of this species and placed it on a near par with woods long regarded as vastly superior.

11. A variety of other activities were engaged in during the year. Members of the Forest Utilization staff again helped organize and participated in the Wood Products Clinic at Spokane, Washington. Dr. Stamm of the Forest Products Laboratory staff lead the panel on chemical utilization and was the principal speaker at the annual Spokane Chamber of Commerce dinner which is held in behalf of the Wood Clinic.

Anderson attended the Chicago and Minneapolis meetings of Pole Committee 05 of the American Standards Association. He discussed the availability of pole species by regions.

Mueller attended the American Wood-Preservers' Association meeting held in Portland, as a member of Committee 5-5-1, Pressure Treatment of Poles.

3. The Forest Utilization Service unit received approximately 200 visitors during the year and prepared 850 letters, memoranda, etc. Timber conversion, largely waste utilization, constituted approximately 20 percent of the correspondence. Subjects under the general heading of cooperation made up about 16 percent, and wood preservation, 15 percent.

Ten representatives of the Forest Products Laboratory and a number of groups of individuals representing private industry were escorted through the region to observe wood-utilization practices.

Anderson delivered a paper on "Trends in Pole Production in the United States and Their Effect on Forest Management" at the annual Society of American Foresters meeting held in Minneapolis, Minnesota. A number of other papers and talks were prepared by Anderson and Mueller on subjects pointing toward better utilization.

B. Plans for 1948

1. The Forest Utilization Service, the Madison Forest Products Laboratory, and other public research agencies and industry work together. Many of the research projects cannot be completed in a year's time and sometimes they are carried forward from year to year. However, the Forest Utilization Service aims to make research results available to industry currently.

2. Research work is pointed directly at assistance to existing industries and the establishment of new wood-using industries. Some of the more important of these aims are:

   a. Better existing wood-using industries and develop new secondary wood-using industries to create new payrolls for an increasing population.

   b. Establish a pole and post industry that is compatible with local forest management needs and integrated with the existing cedar pole and other wood-using industries.

   c. Assist the existing pulp and paper industry, and encourage the establishment of pulp mills in northern Idaho and western and eastern Montana.

   d. Establish a chemical industry in the region using wood as a raw material.

   e. Expand the fibreboard industry to northern Idaho, western Montana, and northeastern Washington.

   f. Establish a wood laminating plant to serve the needs of the region.

   g. Establish a chemical industry in the region using wood as a raw material.

3. Following are a few of the jobs the local Forest Utilization Service will undertake in 1948. Many of them are carry-overs from last year.

a. Survey the waste supply at two or three logical board-plant sites (suggested locations: Hamilton, Kalispell, Spokane, and Coeur d'Alene), procure samples, and furnish Laboratory with a report showing the various amounts of waste available.

b. Assist in the development of possibilities of a fibreboard pilot plant in the Spokane area - finances, etc.

c. Furnish Laboratory with waste material for test board production.

d. Guide and rearrange program to most effectively ward off possibility of use of lodgepole pine for poles coming into bad repute because of inadequate specifications and utilization practices.

e. Continue efforts to develop suitable moisture meter for round-timber industry.

f. Continue service on American Standards Association Pole Committee 05 and on American Wood-Preservers' Association Committee 5-5-1.

g. Prepare series of research notes for each species highlighting the results of pulping tests to date.

h. Make preliminary survey of pulp-mill possibilities in eastern Montana.

i. Continue cooperation with state agricultural college experiment stations for livestock feeding of wood-sugar molasses.

j. Survey wood-waste supplies to determine a suitable location for a fodder-yeast or molasses pilot plant.

k. Make brief summaries in the form of research notes on progress and results of molasses-feeding tests.

l. Arrange for experimental production of 10 tons of pelleted stock food to determine binding (mechanical) properties of wood-sugar molasses.

m. Continue liaison with Underwood Veneer Company, Wausau, Wisconsin, on use of local species for veneer.

n. Follow up on methods of merchandising larch plywood for interior panels.

o. Analyze the situation at those sawmilling operations in the region which show promise of integrating veneer and plywood industry with their operation.

p. Prepare research notes giving results of studies on veneering of (1) black cottonwood and (2) other local species.

q. Continue inspection of laminated mine guides removed from Butte mines and keep service report current; also assist in new experimental installations.

r. Assist the Anaconda Copper Mining Company to develop a laminating department at the company's Bonner, Montana, sawmill.

s. Apply results of Mississippi Valley survey of secondary wood-using industries to local situations with expectation of increasing local wood remanufacture.

t. Assist in procurement of funds for and help construct experimental dry kiln at the University of Montana Forestry School.

Accomplishments in 1947

1. The long-talked-about possibility of fighting fire from the air by aerial bombing was given a real test in 1947. With Air Force cooperation finally arranged for, National Fire Chief, the late David P. Godwin, assigned field tests on actual forest fires to the northern Rocky Mountain region. Recognizing the need for highly specialized liaison with the Air Forces, as well as research requirements essential to good testing, Regional Forester Hanson requested the assistance of our Experiment Station. J. S. Barrows of our Division of Fire Research, a wartime lieutenant colonel in the Air Force, was assigned to this job. A full six months of his time was devoted to the project.

Results were highly promising and should point the way to a new and very beneficial use of aircraft against the most critical fires in rough mountainous country. Two P-47 Thunderbolt fighters each dropping two 165-gallon tanks on minimum level glide runs performed satisfactorily on the test fires. They also carried on to bomb a few actual lightning-caused fires near the end of the season. A B-29 Superfortress carrying eight specially modified 165-gallon water bombs demonstrated the possibilities of aerial bursts of water over small hot fires. The B-29 phase of the tests was not completed during 1947. However, these tests did go far enough to show that clouds of fog and water vapor up to a volume of 1,320 gallons spread over a length of 1,000 feet can be created by proximity fused bombs dropped from a single B-29. Adequate tests of chemical fillings instead of water also were not completed.

Three reports have been issued on this project. In August 1947 a 13-page illustrated progress report was prepared by Regional Forester Hanson and Station Director Tebbe briefly describing the purpose, procedures, and results from the Forest Service standpoint. Only a limited issue of this report was mimeographed and the supply soon was exhausted.

Late in August a 3-page statement was issued by an "Aerial Bombing Evaluation Board" which had been specially appointed to appraise this experiment. This Board consisted of the State Forester of Oregon, Regional Fire Chiefs or their representatives from San Francisco, Portland and Ogden, representatives from two National Forests, Lt. Col. Keilman of the Air Proving Ground Command, and the chief of our own Division of Fire Research. This Board was given the important responsibility of determining the feasibility of aerial bombing based upon information then available.

The report by the board lists three troublesome situations or conditions in fire control on which help has long been needed from some source, and on which aerial bombing now clearly offers promising possibilities. This report also lists six possible military advantages which may be deemed important enough to justify the Air Force bearing the cost of such bombing. Finally, it rates the results to date as very successful in retarding the spread of threatening fires, and advocates expansion on an "operational basis" by bombing actual fires both small and large in 1948. Copies of this report are obtainable from our station.

The third report entitled "Tactical Evaluation of Aerial Bombing Fires" is a comprehensive 83-page, illustrated document presenting all important details of the experiment as well as specific Air Force and Forest Service conclusions and recommendations. This report was prepared jointly by Air Proving Ground Command project officers and the Experiment Station. It has been published in printed form as an official report of the Air Proving Ground Command for distribution only to the Armed Forces and the Forest Service. It recommends that more planes be assigned to the work in 1946, that the big bombers test operations on the hot fronts of big fires as well as on little ones, and that a new bomb of larger capacity and better ballistic qualities be developed primarily for fire use but also for other military purposes. This latter recommendation is the key to successful future operations and is the most important step now to be taken in making aerial bombing become an important new technique of forest fire control.

The research phase of forest fire bombing is by no means completed. Tests of chemicals and formation bombing, detailed studies of the effects of aerial fog under various fuel conditions, experiments with high explosives on snags and heavy fuels and the determination of when and where to bomb most effectively are all lucrative fields for additional research. However, research has gone far enough to turn the major part of the project over to the administrative organization. Many of the problems now remaining can be worked out jointly by the administrative organization and the Air Force during the transition stage from purely experimental work to limited operations on going fires.

2. In fire control engineering the success of the aerial bombing project and other recent developments have accentuated the recognized need of reexamining our previous principles and procedures. The several new and the old techniques and devices of fire control must now be fitted together in a well coordinated design. We must now add aerial bombing to smokejumping, aerial detection, and other recent developments in presuppression planning. Also it seems probable, although tests have not yet been made, that aerial bombing can be added to power pumps, tank trucks and mechanical

line builders as new fire equipment which are revolutionizing suppression strategy and tactics.

The overall fire control picture in the northern Rockies has changed greatly in the last ten years and will change much more in the period immediately ahead because of scientific developments which have rendered certain previous planning techniques and principles wholly inadequate. It is now almost universally recognized that the design of the future fire control organization fully utilizing smokejumpers and bombing on small fires will be quite different from that of ten years ago which relied entirely upon ground travel of the initial attackers. Similarly the principles of designing facilities and services to control fires that escape initial attack will be quite different. In the future more reliance will be placed on bulldozers and bombers. Road construction and maintenance to insure fast arrival of both the "first line" smokechasers and the heavy reinforcements in men of the "second line defense," as planned 10 to 15 years ago, may be greatly reduced.

Other recent developments also affecting future fire control are becoming increasingly important. Most significant are: (1) the substitution of airplane detection in place of large numbers of ground lookout stations; (2) greatly increased values for some of the formerly "minor" timber types; (3) new harvesting practices in timber sale operations; and (4) changed fuel types, particularly the acreage of logging slash.

Our fire control engineering research program is tackling many of these intricate problems in fire protection design. The first step is to assemble and analyze the basic information needed to establish fundamental principles. The main source of such information is in our fire reports. Records for 23,000 fires that had been currently coded and placed on punch cards were available. These cards have now been sorted and the data tabulated to provide new and up-to-date information on the following features of the fire problem:

a. Fire load	e. Communication	i. Heavy reinforcements
b. Fuels	f. Transportation	j. Fire behavior
c. Prevention	g. Initial attack	k. Cost and damage
d. Detection	h. Light reinforcements	

The analysis of our fire control plant operations is 50 percent complete. Our research in this field has already revealed new techniques applicable to this important fire control engineering operation. In addition, even in its incomplete stage, this work has revealed significant information which will be of value in perfecting the design of future fire control services and facilities. A few of the high-lights are as follows:

Study of the fire load for 1931 to 1945 has revealed several significant facts: - (1) The average load is 1,500 fires per year, with 1,096 bunched in July and August and only 404 fires in the other 10 months; (2) variability of the annual load ranges from 628 to 3,595 fires per year; (3) peak ten-day periods are July 11-20 with an average of 234 fires, and July 21-31 with 257 fires; (4) peak daily loads occur almost every year on almost every Forest. The Clearwater Forest, for example, has to handle ten or more fires in one day in 14 out of 15 years; peaks of 20 or more fires on one day in 11 out of 15 years, and 30 or more fires in one day in 8 out of 15 years.

Studies of fire prevention results are showing the progress made in 15 years and identifying the critical elements in the fire prevention effort. Twenty-four percent of the fires and 46% of the area burned are the result of man-caused fires. In the last five-year period the number of man-caused fires was reduced to 20% but the area burned jumped to 67%. Smokers cause the greatest number of man-caused fires as well as the greatest area burned. The greatest fire prevention improvement is shown for incendiary fires, but railroad fires have increased. Farmers, stockmen, fishermen, and travelers are the worst fire prevention offenders.

Analysis of the records proves that cutover lands in this region contain more dangerous fuel conditions than even old burns, which formerly have been rated as among our worst. Only 67 percent of the fires on cut-over lands are being held to class A size as compared to 85 percent in old burns. Expressing this condition in another way 9 percent of the fires on cut-over lands reach class C or larger size compared to 4 percent in old burns. Digging deeper into the cutover lands problem we find new evidence that methods of slash disposal are a key factor. The fire records show the astonishing fact that there is little difference between the effectiveness of piling and burning slash and piling it without burning. But, either piling and burning or piling without burning is twice as effective as broadcast burning, and four times as effective as leaving slash broadcast and unburned.

3. On firefighting equipment no work is being done by our Experiment Station. The Regional Offices of Fire Control and Engineering, the National Equipment Committee, and several other agencies are working very effectively in this field. The Regional Office is doing some particularly effective work to determine maximum probable needs of certain types of equipment. We do not believe that we should scatter the limited efforts of the two men in our Division of Fire Research by spending any time on equipment.

4. On aerial detection of fires we have similarly refrained from spending time although this field is so promising that in 1947 the Supervisor of the Coeur d'Alene Forest made a real research

test. While results of a single year are never conclusive in any test of fire control the Coeur d'Alene trial clearly demonstrated that certain impediments are not as serious as they have been judged. In some phases of aerial detection such as height to fly, sun's angle, etc., we believe that we should accept research results obtained in other regions or by specialists who can temporarily be borrowed from other Experiment Stations.

5. Fire control results in 1947 emphasized two functions of Fire Danger Measurement Research. First is the need of fire danger measurements suited to presuppression action. Second is the need of a Fire Dispatcher's Guide aimed separately at fighting small fires. Several cases in 1947 indicated that both initial dispatching and control work on small fires can be made superlatively costly. Apparently the objective of "control by 10:00 a.m." can be sought so vigorously that costs will be skyrocketed beyond balance with the small additional reduction in acreage burned.

It is obvious, of course, that the speed, strength, and vigor of attack on fires should be greatest under bad burning conditions - class 70 and higher. However, if this same speed and strength are poured onto new fires when the Burning Index is class 50 or lower, the cost is sure to be greater than if due consideration were given to the fact that under favorable weather fires will spread slower and can be controlled with less men.

The future use of Burning Index ratings to influence strength of attack is a new refinement which markedly accentuates the need of a Burning Index Meter for each Fuel Type. This is essential if the Dispatcher, the Ranger, and the Supervisor is to be so sure of the Burning Index that he can safely take the chance of sending less and less men as the Burning Index drops lower and lower. While the present methods and places of measuring Burning Index probably give dependable Indices for 80% to 90% of our fires no Ranger or Supervisor can be expected to risk his official neck and reputation by gambling on the behavior of the other 10 to 20 percent.

One remedy apparently lies in determining two things more precisely than they are now known. These are (1) where to make measurements of burning conditions so that no bad fuels are in areas "blind" to our danger measurements, and (2) so that with the measurements made at proper spots the Ranger or Supervisor can be more sure that he is with our present data of the behavior to be expected. This means better knowledge of rate of spread of fire in each fuel type under any combination of weather conditions, especially under relatively "easy" weather. Also, it means far better fuel type maps than those now available. This in turn means better principles and methods of classifying fuels into rate of spread types. These are all jobs which Research should tackle in the near future. They cannot be done overnight or at the office desk.

Progress was made on three other phases of Fire Danger Measurement in 1947. These are (a) identification of differences between easy, average, and critical seasons; (b) presuppression manning according to the curve of normal fire danger; (c) precipitation probabilities.

(a) The four sets of large logs at Priest River revealed the lowest moisture contents so far recorded in early May despite nearly normal winter precipitation. This is additional evidence that winter snow depth or snow moisture content is not a dependable index of a critical fire season. The low moistures measured in May 1947 were, however, used as a warning that the 1947 season could become critical. Fortunately heavy rains in June eliminated that danger.

(b) Field criticism of the Burning Index obtained from the Model 6 Danger Meter has again highlighted the need in Region One of a financial policy which will permit manning to a curve of normal danger even when actual burning conditions are lower than normal. Analysis of the 1947 complaints indicated that actual burning conditions were not seriously out of line with the Danger Meter ratings. The complaints arose, instead, from the fact that in July the new Model 6 meter gives lower ratings than the old Model 5. This in turn reduces the July manpower on duty below that which field men believe is essential as a skeleton for expansion to meet possible or even probable August dangers. The cause of the field complaints is obvious. Research contends, however, that the primary function of danger rating is to rate danger. Manning according to prevailing danger, and financing organizations of any predetermined strength, are altogether separate functions. They are believed to be jobs for administrative solution.

(c) Determining the statistical probability of the occurrence of critical fire seasons and of critical periods in each fire season should be an aid to fire control planning and action. During 1947 work was commenced on both of these. Ratings were obtained for each season 1906 to 1933 that are comparable with our meter-measured ratings from 1934 to date. Statistical examination will be made to determine whether these 43 cases constitute an adequate basis for expressing probabilities.

Similarly the probabilities of rains of 0.20 inch or more, 0.40 inch or more, and 1.00 inch or more in any 10-day May 1 to October 31 were computed from the Priest River records. While such characteristics are generally known in rough approximations the new data are definitely specific. Furthermore, the analysis found that these probabilities have been changing throughout the past 25 years, some increasing, some decreasing. An article explaining the method of compilation has been submitted for publication.

B. Plans for 1948

1. Fire research funds and personnel are still out of balance with both the size of the fire problem and the distribution of research on other phases of forestry. Very little improvement has been made in the situation as reported a year ago.

2. Fire control planning continues to be our greatest need and opportunity. Happily, some results now are beginning to come from this work and many more may be anticipated in 1948, even though Barrows has no technical help on this big project. The application of six months' time by Barrows to the Bombing Project in 1947 naturally did not expedite his Fire Control Planning analyses. However, if adequate compilation assistance can be obtained in early 1948, this project should be about 75% completed by the end of the year. Special attention is being given to pressing features such as the slash problem, new suppression technics, and the use of these technics to revamp both presuppression and suppression planning practices.

3. Revision of our system of classifying fuel types is contingent upon compilation and analyses of the fire reports. Much new data already is available concerning rates of spread. One promising aid in this work consists of a new ecological method of classifying vegetative types recently outlined by Professor R. F. Daubenmire of Washington State College. This method accents the forest "undergrowth types" in addition to tree species. Undergrowth types are obvious fire carriers which have not previously been given systematic recognition in our fuel typing. Another aid may also be found in Wellner's new method of estimating light intensity beneath the forest canopy. All of this information must be assembled and studied with the intention of improving our present, rudimentary fuel typing procedures.

4. Fire Danger Measurement research in 1948 will be confined to a continuation of the large log study, an analysis of "The Problem and Probabilities of the Critical Fire Season," an analysis of the representativeness of fire danger station data or "sampling," and to certain new developments such as radar detection of lightning storms and dry-icing clouds to make rain and break up incipient lightning storms.

5. Cooperation with the Universities and with local timber protective agencies will be continued. A report on Gisborne's inspection of the Yellowstone Park fire problem, made last September, is still not completed.

6. For the forthcoming book "Forestry in the U.S., 1900-1950" to be published by the Society of American Foresters, Gisborne has been

assigned the chapter on Forest Protection. This will require several weeks work in 1948, and 1949.

7. Preparation and delivery of talks to clubs, lectures to students, and papers before scientific associations and other meetings can be expected to take a large amount of time by both Barrows and Gisborne in 1948. The subject of aerial bombing has proved to be of exceptionally wide interest. The Montana Society of Engineers has asked for such a talk. Barrows will give it, and will report his results on the slash problem at the spring meeting of the Northern Rocky Mountain Section of the Society of American Foresters. Gisborne was invited to be the banquet speaker at the Syracuse New York meeting of the New York Section of the Society on February 5 and to participate in the two-day program devoted to forest protection. En route to this meeting he will visit the Pittsfield, Massachusetts, and Schenectady, New York, laboratories of the General Electric Company to obtain new information on lightning, on protection of our facilities from lightning, and on "seeding" clouds to make rain. Returning, he will attend the February 9-13 National Fire Meeting in Washington. He has been invited to serve as discussion leader of one subject on the Reno, Nevada, program of the Western Snow Conference meeting in April, and to lecture to the University of Idaho students in forest protection that same month. Both Barrows and Gisborne also expect to be asked for lectures again this year to the Iowa State College of Forestry summer camp on our Priest River Experimental Forest.

A. Accomplishments in 1947

Artificial Range Reseeding

1. Preparation of manuscripts has been the major project during the past year. Results of airplane reseeding work on the Henry Creek and O'Keefe Creek burns and some of the factors contributing to success and failure were described in a 7-page research note published in June.

A guide for reseeding range lands on and near the national forests of Montana was published as a 58-page station paper in October.

A paper on seeding forage plants on burned and cut-over land in western Montana was presented at the Northwest Scientific Association's December meeting at Spokane, and is to be published in Northwest Science.

Much of the ground work, compilation, and analysis has been done for a progress report on species adaptation tests for central Montana.

2. Analysis of recent data provides helpful pointers on methods of planting and seedbed preparation. Chances of controlling cheatgrass by burning are discounted by results of a test conducted at the Antrim experimental area in the Bitterroot Valley. Burning reduced the average number of cheatgrass seedlings present in October to only 20 percent of unburned plots. Even on the most successful burns, however, where cheatgrass seedlings were reduced to 8 percent, there were still 19 to 20 young cheatgrass plants per square foot. Crested wheatgrass, which was drilled into the burned plots in the fall, have not yet produced satisfactory stands on any burned plot, but did produce a fair stand on unburned plots which were plowed and harrowed before drilling.

The importance of prompt seeding of relatively clean stubble land has been demonstrated at the Judith Basin area in central Montana. Average stand rating (on a scale of 0 to 10) for the 7 most successful species was: (a) on the fresh stubble "8" or "good;" (b) on the land abandoned 2 years "3" or "poor" and, (c) on the land abandoned 4 years "1" or "very poor." Increasing competition, especially cheatgrass, appears to be the main factor responsible for the poor failures.

That stubble land too weedy to be successfully seeded in the fall without cultivation can sometimes be clean cultivated and spring seeded successfully was demonstrated at both the Bitterroot Valley and Judith Basin areas. At the former, crested

and intermediate wheatgrass were seeded in the spring of 1946 on weedy stubble land, part of which was clean cultivated just before seeding. The average stand rating (on the 0 to 10 scale) was "2.5" on the uncultivated and "6" on the cultivated seedbed. At Judith Basin half of a weedy stubble area was cultivated in the fall of 1944. Then half of the cultivated and half of the uncultivated area was fall drilled and the remainder drilled the next spring. For the 5 most successful species (crested wheatgrass, slender wheatgrass, tall oatgrass, meadow brome, and Ladak alfalfa) the average stand ratings in 1947 were: fall - uncultivated "1.8," cultivated "2.2;" spring - uncultivated "2.8," cultivated "5.8." Thus at both areas the only satisfactory stands obtained under weather and other conditions prevailing were on the clean cultivated seedbeds from spring planting. This leads to the conclusion, considering past experience, that very weedy seedbeds may be cultivated and seeded in the spring, but that seedbeds clean enough for seeding without cultivation may best be seeded in the fall.

3. Seasonal stages of plant development show some striking differences between six of the most promising species at the Antrim area. In order of earliness they are (2-year average): big bluegrass, sheep fescue, Russian wildrye, meadow brome, crested wheatgrass, and intermediate wheatgrass. Big bluegrass reaches the boot stage about April 20 and intermediate wheatgrass about May 25, five weeks later. Seed of big bluegrass begins to ripen about July 1, a few days before intermediate wheatgrass begins to bloom and just about the same time that crested wheatgrass is entering the dough stage. This information should be helpful in selecting species for use in mixtures or in planning grazing rotations between pure stands to make green forage available during the longest possible time.

4. Intermediate, beardless, bluebunch, and slender wheatgrasses, meadow brome, and sheep fescue outyielded crested wheatgrass in 1946 and 1947, both very favorable seasons, at Judith Basin. At the Antrim area where growing conditions are less favorable, crested wheatgrass ranked better but was still outdone by intermediate and bluebunch wheatgrasses, and big bluegrass. Species were sampled in the hay stage, so this does not mean that the same yield relationships would hold under grazing. Several more years of comparison will be needed before final conclusions are drawn.

5. In October, the station cooperated with the Cabinet National Forest in a 15- to 20-acre pilot plant seeding on cheatgrass-infested native range land recently acquired for administrative use at the Plains Ranger Station. A mixture of 7 species was broadcast on varied seedbed preparation. In addition, 16 species were planted in range plots with two intensities of preparation and 12 more species were planted in species adaptation row plots.

6. A sagebrush study was started to test fire as a tool in improving forage production on big sagebrush range lands. Although big sagebrush (Artemisia tridentata) has some value for grazing, it becomes so thick on a few ranges of southwestern Montana that availability, quantity, and quality of more desirable forage species is reduced. Lamb losses are increased from straying or predators, and wool losses result from being snagged by brush.

The study was set up on the Whitworth Brothers' private range adjacent to the Beaverhead National Forest on a cooperative basis to determine the results of burning for converting sagebrush areas into more productive and usable grassland. Methods developed by the Intermountain Forest & Range Experiment Station at Dubois, Idaho were used. The study was to test relative effects of: (1) burning with one year of protection from grazing followed by moderate grazing, and (2) a control on which past use practices will be followed, i.e., grazing and no burning. Records made just before the burn include estimates of forage density and availability, evidences of erosion, sage plant counts and yield. Burning was done in early September with a clean-up burn several days later under somewhat adverse weather conditions. No results are yet available.

7. How young crested and beardless wheatgrass plants develop pedestals on ungrazed range is the objective of a study started at the Antrim experimental area. Pedestals as a criterion of range condition and trend cannot be properly evaluated until their development is understood more clearly. The crown and soil level of 20 seedlings for each species started in the spring of 1946, were recorded in the fall and the plants were marked for subsequent measurements. All measurements are made with a transit and recorded to the nearest 1/100 of a foot, computed from a reference stake set in concrete below the frost line.

Low pedestals developed in one year according to remeasurements in October 1947 when they averaged nearly 0.2 inch above the soil for crested wheatgrass. About two-thirds of this height was probably due to frost action in the winter of 1946-47. Sheet erosion removed soil enough to account for the remaining third. Crowns of the beardless wheatgrass were also elevated, but slight soil deposition around the plants made it less evident.

8. A manuscript has been prepared for Departmental publication on the subject "When to Start Grazing Summer Cattle Ranges in Southwestern Montana." Mountain summer range should ordinarily be opened for grazing on the earliest spring date that livestock can make good gains on the forage available without undue sacrifice of range or watershed values. Forage changes from a palatable watered concentrate in the spring to a roughage four months later, which points up the need for early grazing. Often, the lower spring ranges are overcrowded and need relief as early as possible. But too early use damages forage, soils, watershed values, and stock do not do well. So an opening date properly balanced between early and late use is highly desirable.

Some of the highlights from this prepared publication of Vigilante data follow: Readiness is best indicated by the development of the key forage plants. On the Vigilante range, appearance of the "boot" stages of Idaho fescue (Festuca idahoensis) and Sandberg bluegrass (Poa secunda), based on density, clipped yields, utilization, and other data, indicate that the forage and soil are ready for grazing use. But in 3 of the 7 years studied, so few boots appeared that this criterion was not very helpful to the range manager. Leaf heights of Idaho fescue and bluebunch wheatgrass (Agropyron spicatum), reached at the boot stage in years when boots appeared, are useful to indicate readiness in years when no boots appear. Leaf heights vary on different sites and ranges, so it is necessary to establish standards on sites similar to the one where readiness is to be determined. The date of
9. flowering or leafing of many weed and browse plants can also be used to supplement and strengthen leaf height data on opening dates.

Creek bottoms, which are now carrying the burden of grazing, are able to withstand more use than dry hillsides. Soil is relatively level and species found there are likely to be more grazing-tolerant. Allowable use on hillsides decreases with steepness, and is probably less on some soil types than others. Watershed and other factors bear on the problem. Some exploratory work has been done at Vigilante, but much remains to be done on this utilization and distribution problem on mountain summer ranges. Questions to be answered are:

1. How much use by cattle will varied slopes withstand?
2. What management can be used to induce the cattle to graze on these now unattractive areas to the desired degree without overuse elsewhere?

Some possible solutions which will be considered are:

a. Use by two classes of livestock at the same or different periods.
b. Use of inexpensive electric fences.
c. Increased and improved herding.
d. Provision of water and shade where needed.
e. Trails into areas of poor accessibility.
f. Use of insect repellants and sprays.
g. Others.

Final conclusions on utilization standards will depend to a substantial degree on how objectives in watershed management for this range are specifically affected by varied use. Objectives for range management should be correlated therewith. Studies should also be correlated to the extent possible with facilities available.

Survey selected areas infested with Wyethia (spp.) to record its spread and reasons therefor. This pest appears to be spreading into grassland ranges at 8,000 to 10,000 feet on the Beaverhead National Forest, resulting in reduced forage production and possibly to increased run-off. Also, tall larkspur (Delphinium robustum) infests certain high grassland ranges to cause losses and complicate management. Exploratory studies are needed to provide a basis for more specific research on how to control these pests.

Management of Short-Grass (Mixed Prairie) Ranges

9. Preparation of three new publications was advanced during the 1947 season: (1) an analysis of range problems of the Northern Great Plains, (2) the response of short-grass range vegetation, soil, and cow-calf production to 13 years of heavy, moderate, and light stocking, (3) the effects of heavy and conservative stocking on range calf crops and subsequent growth through long yearlings. Work was also continued on 3 older, proposed publications carrying management guides for short-grass range.

Continued analysis and integration of data from the cattle-stocking study required considerable time in 1947. However, some field work was done to round up loose ends, and soils from the differentially stocked pastures were analyzed for percentage organic matter.

10. Soil organic matter was reduced by heavy stocking. Differences in the surface 2 inches of soil between heavily and more conservatively stocked ranges were small but consistent for the 3 soils types compared.

Table 1. Percentage organic matter (C x 1.724) of surface 2 inches of soils from heavily and conservatively stocked pastures, 1946.

Past Rate of Stocking	Sandy Upland	Clay Upland	Clay Bottom
	Samples per Area		
	90	96	90
Heavy	1.61	2.18	2.61
Light	1.74	2.23	2.74
Moderate	1.88	-	-

In terms of the total soil organic matter typical of these semiarid lands, these small differences amounted to 2 to 7 percent less organic matter for the heavily stocked soils.

Greater change or reduction might reasonably be expected with continued heavy stocking and heavy forage utilization. At the time the project was terminated, potential sources of soil organic matter were less on the heavily stocked than on the more conservatively stocked pastures. Forage production averaged approximately 27 percent less, accumulated plant debris or mulch on the soil surface was only about half as abundant, and weight of roots per unit of soil was also less.

11. The reduced water-absorbing ability of soils of the heavily stocked pastures resulted largely from greater soil compaction through more concentrated trampling and scantier surface mulch accumulation. Texture and organic matter content of the soils compared were too similar to account for the heavier volume-weight and the 7 to 20 percent reduction in non-capillary pore space of heavily stocked soils. However, the slightly smaller amount of soil organic matter plus the poorer development of roots for the heavily stocked ranges may have contributed to reduced absorbing ability.

12. Poorer soil condition of the heavily stocked pastures may explain in part vegetative changes apparent in 1946. Compared to more conservative use, heavy grazing reduced both quantity and quality of forage through partial replacement of high yielding mid-grasses by short-grasses, poorer forage grasses, and weeds, and by impairing height growth and vigor of major forage grasses.

13. Possibilities for reliable forecasts of forage crops on short-grass ranges based on weather data appear limited. Except for rapid and drastic decrease due to severe drought-kill of perennial grasses, annual fluctuations in production are largely due to changes in height growth. Based on records

from Miles City for the years 1933 through 1945, height growth depends largely on precipitation during the months of April through June of the current growing season.

For these years, current precipitation during the months of April through June accounted for 66 percent[1] of the variance in forage yields[2] on the conservatively stocked pastures. Little correlation existed between forage yields and precipitation during the preceding growing seasons and/or the preceding fall months. However, exceptionally heavy fall rains in 1946 resulted in a good forage crop in 1947 even though rainfall was scanty during that growing season. But such fall precipitation is unusual at Miles City.

Much additional study will be required to determine accurately the possibilities of forecasting forage crops which are tied so intimately to preceding and current weather.

14. The value of crested wheatgrass for early grazing use and rapid steer gains was strikingly underscored. The heavily used 46-acre crested wheatgrass pasture at Miles City, on which yearling steers made good gains during the past 8 seasons, was stocked with 14 two-year-old steers in 1947. In 98 days, between April 22 and July 29, the steers averaged 318 pounds gain or 3.2 pounds per day. This compares well with the 2½ pound average daily gain normally accepted as satisfactory for a 150-day fattening period in feedlot on concentrated feeds. High market quality of these grassfat steers is shown by the sale price of 25 cents per pound at a local market for a few days after the grazing test was closed.

Gains averaging 4.3 pounds daily to mid-June were considerably greater than those later in the season. During the last two weeks of July weights were roughly maintained. This seasonal trend probably reflects the varied quality of crested wheatgrass forage from green succulence through maturity and curing.

15. Results of management studies were explained to stockmen and members of other agencies and institutions. Two field days were held at Miles City in 1947 for on-the-ground inspection of native range and reseeded pastures. In all, 66 ranchers and members of the Production and Marketing Administration and the Soil Conservation Service attended. Selected phases of the experimental work also were explained at annual meetings of the American Association for the Advancement of Science at Chicago, and the Northwest Scientific Association at Spokane in late December, and at the Station's annual range investigative meeting in January. Significant highlights were carried currently in local newspapers.

1/ Coefficient of determination (= correlation coefficient).
2/ Calculated from animal days on pasture, weight of animals, estimated forage consumption (pounds), and percent forage utilization.

B. Plans for 1948

Artificial Range Reseeding

1. Manuscript preparation, particularly completion of a manuscript on species adaptation in central Montana, will be stressed in 1948.

   If time permits, research notes or farm journal articles may be prepared to report on the cheatgrass burning experiment, and to encourage prompt seeding of land being retired from crop production.

2. Little new planting is planned for 1948. Routine observations and measurements of experiments already under way will occupy available field time of present personnel.

3. Field days will be conducted to encourage ranchers and others to make use of information available.

Management of Summer Ranges

4. The sagebrush burning study will be continued. Sample areas will be reworked, records maintained, and some summarization of data is to be accomplished during the year.

5. The Vigilante experimental range will be re-opened this spring. Field work has been dormant there since 1944 as all personnel went to war. Studies planned for 1948 are as follows:

   (a) Utilization standards for cattle ranges will be further developed with special attention to slopes.

Management of Short-Grass (Mixed Prairie) Ranges

6. Completion of manuscripts for Departmental publication is top priority. In addition to six manuscripts in various stages of preparation, a seventh is also planned for 1948, i.e. a farmers' bulletin account of what the three rates of stocking mean to stability of livestock operations.

   The problem analysis will serve as a basis for future research on management of northern short-grass ranges. Study plans for some more pressing projects will be developed promptly.

7. The experimental pastures will again be stocked as near previous standards as possible to facilitate further testing cumulative effects of moderate and light stocking. Ranchers and range managers have urged a longer-term evaluation of these rates over a period encompassing greater weather variation.

Heavy grazing on the experimental crested wheatgrass pasture will be continued to supplement present knowledge.

8. Long-term studies on response of vegetation on grazed range to weather variations will be picked up again in 1948. Because weather has continued favorable since observations were last made in 1944 or 1945, the opportunity now exists to record the peak or near peak condition of range sovor after one of the longest and most favorable periods of weather on record.

9. Base information will be completed for a study of the recovery rate of heavily used range in poor condition. This study was set up on a stock driveway at the U.S.R.L. Experiment Station at Miles City in 1947 and initial observations partly completed.

10. Guides will be developed for judging condition and trend of northern plains ranges by sites (major subtypes), drawing generously from basic data provided by the experimental pastures at Miles City. The guides will be checked on outside ranges and extended to include sites not fully represented in the experimental pastures.

DIVISION OF WILDLIFE INVESTIGATIONS

A. Accomplishments in 1947

1. The study of deer browsing injury to ponderosa pine reproduction was continued. In the northern Rocky Mountains, Douglas-fir, an economically inferior species, is crowding out ponderosa pine reproduction. There are indications in certain localities that deer are accentuating this undesirable trend by browsing and killing the ponderosa pine. A study to evaluate the effects of deer browsing on ponderosa pine reproduction was initiated in the fall, 1946, on the Kootenai National Forest. There, both white-tailed and mule deer are abundant, the ponderosa pine is especially important in sustained yield timber management, and the condition of the pine reproduction is particularly unsatisfactory.

   The reproduction is browsed by the deer primarily as a winter food. So the study began with a winter-long investigation with regard to numbers of deer, their distribution in relation to ponderosa pine, chronological sequence of their use of pine reproduction, and the relationship of pine to other components of the deer's diet.

   In spring, following the winter investigations, a detailed study of the deer's winter use of vegetation was made by the sample-plot method. Data were obtained to show the amount of the various winter browse species available, the relative extent of their use by deer, the relative position of different species of conifers in the deer's diet, the status of reproduction of Douglas-fir and ponderosa pine, the relative intensity of use by deer of these two species, and the relative browsing withstandability of the two species.

   Supplementary information on the influences of hunting, predation and winter kill on the deer and their food habits were also obtained during the winter and spring studies.

   Seven deer exclosures, with paired check plots established in 1946 to study the relationship of deer-browsing to ponderosa pine seedlings, were observed through the 1946-47 winter. In April they were intensively surveyed to determine the extent of use of planted pine seedlings by deer in the check plots, the density, composition and relative use of plant species, and the abundance and use of the black moss (*Alectoria Fremontii*), an important winter browse species which grows as an epiphyte on trees and tall shrubs.

   During the summer, work on the deer investigations were suspended pending studies of wildlife in relation to DDT in Idaho and

Wyoming, and a big game survey in Glacier National Park. The work on the deer investigation was resumed in the fall with the compiling and analysis of data obtained during the preceding winter and spring. This work continued throughout the remainder of the year as a part-time activity interspersed with the writing of other reports, plans, etc.

The above studies of deer and pine leave two important questions unanswered. First, with a given amount of browsing, how much has a plant been retarded in its growth, and, second, what percent of the plants have been killed? Plans for experiments to answer these questions were drawn up during the past winter.

2. The effects of DDT on wildlife were investigated. During the summer two important forest insect control projects were instituted by the Bureau of Entomology and Plant Quarantine and the Forest Service. At the request of those agencies investigations were made of the effects of the DDT on the vertebrate wildlife in the forests. In Idaho over 400,000 acres of forest were treated with one pound of DDT per acre to control the tussock moth. Birds and mammals were not appreciably affected by the treatment. Some rough fish were killed, but trout and forage fish survived. The aquatic and terrestrial invertebrates used by fish for food were markedly reduced in numbers, but apparently there was no starving effect on fish. In Wyoming 500 acres were treated with 5 to 7½ pounds of DDT per acre in an experimental attempt to control mountain pine beetle. A few trout were killed, but many survived. Food organisms were killed in great numbers, but again no harmful effects on fish were apparent. A few songbirds were killed, though not in sufficient numbers to have a lasting effect on bird populations. The effects on mammals appeared to be extremely slight. There was inconclusive evidence to indicate that shrews and chipmunks were adversely affected to a small extent.

3. Big game in Glacier National Park was investigated. In August, 10 days were devoted to a study of exclosures and big game ranges in Glacier National Park in cooperation with Dr. J. W. Severy, Montana State University, and members of the National Park Service. The ranges were found to be in poor condition and recommendations were made for herd management, with emphasis on the need for reductions.

4. Plantation studies were resumed. In anticipation of an early project to study the effects of wildlife on forest plantations, a brief inspection of plantations in northern Idaho was made in July with G. M. DeJarnette, Forest Service, Region One, who is in charge of planting. Plans were made for surveys of study plots established before the war to study the effects of rabbits on plantations of white and ponderosa pine in brushfields.

B. Plans for 1948

1. Deer - pine investigations will be continued. It is planned to continue the analysis and report of field data from the Fisher River. This work will be finished in 1948. The deer exclosures on the Fisher River will continue to be maintained with the primary objective of determining whether conifer reproduction will voluntarily appear in the absence of deer browsing. Studies designed to calibrate the effects of known intensities of (simulated) browsing will be initiated early in 1948. This will be a long-term program (possibly 10 years) requiring attention for a week or two each year.

2. Plantation - wildlife studies will be continued. These studies will begin with an analysis of the pre-war rabbit-study plots to determine whether significant data are available from them and what future use can be made of those or similar plots. Following the initial survey, plans will be developed for a comprehensive study of the problem of animal influences on plantations.

DIRECT AND INDIRECT COSTS BY FINANCIAL PROJECTS

F. Y. 1948

Financial Project	Indirect project costs (overhead)	Direct project costs	Total costs
Forest & Range Management	$ 11,770	$102,800	$114,570
Forest Products	1,000	19,000	20,000
Forest Resources Investigations	5,700	41,800	47,500
Total	$ 18,470	$163,600	$182,070

DISTRIBUTION OF DIRECT COSTS BY MAIN PROJECTS

F. Y. 1948

Financial and work project	Cars, maintenance & new	Scientific equipment, etc.	Travel expenses other than cars	Salaries: Regular	Salaries: Temp.	Total
FOREST & RANGE MANAGEMENT INVES.						
501	$ 200	$2,645	$ 2,700	$ 32,485	$5,100	$ 43,130
503			20	2,925		2,945
510		590	350	5,100	285	6,325
520	100	422	500	15,008	425	16,455
540	200	1,860	2,485	27,750	1,650	33,945
Total	500	5,517	6,055	83,268	7,460	102,800
FOREST PRODUCTS						
575	100	213	725	6,372		7,410
580		106	265	6,659		7,030
585		73	280	1,357		1,710
590	100	433	595	1,722		2,850
Total	200	825	1,865	16,110		19,000
FOREST RESOURCES INVESTIGATIONS						
601	300	1,550	3,000	16,950	200	22,000
602	100	920	2,800	14,930	1,050	19,800
Total	400	2,470	5,800	31,880	1,250	41,800
Grand Total	1,100	8,812	13,720	131,258	8,710	163,600

PUBLICATIONS

1. Issued During 1947

Adams, Lowell
Observations on deer and hunters in the Fisher River district, Montana. Research note 48. March 1947. Mimeo. 4 pp.

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Deer on Fisher River. Outdoor Montana, vol. 2, no. 4. August-September 1947.

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The effects on mammals of DDT used in the control of tussock moths in northern Idaho. September 1947. Mimeo. 9 pp.

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The effects on mammals of DDT used in forest insect control in the northern rocky mountains. Research note 56. November 1947. Mimeo. 3 pp.

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First annual report on white-tailed deer exclosure plots on the Fisher river, Lincoln County, Montana. November 1947. Processed. 8 pp.

Anderson, I. V.
The merits of lodgepole pine poles. November 1947. Mimeo. 6 pp.

Barrows, J. S. and Neilman, M. H.
Tactical evaluation of aerial bombing of forest fires. The Air Proving Ground Command, Eglin Field, Florida. November 1947. Mult. by the Air Forces. 83 pp.

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Bombing fires with water. Proc. 38th annual meeting, Western Forestry & Conservation Assoc. December 1947.

Dickerman, M. B.
Lumber production gains in the northern rocky mountain region. Research note 53. August 1947. Mimeo.

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1946 - a peak year in pole production. Research note 54. August 1947. Mimeo.

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Conversion factors in forest survey work. September 1947. Mimeo. 20 pp., tables.

Dickerman, M. B.
Forest destruction in Greece - one reason for economic chaos. American Forests, May 1947.

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Translation: Aims and problems of Italian forestry. By Aldo Pavari.

Forest Utilization Service
Review of tie specifications and prices in the Montana-Idaho territory as of December 1946. Jan. 21, 1947. Mimeo. 2 pp.

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Supplement #1 to above tie specifications and prices. February 14, 1947. Mimeog.

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Test of hemlock railroad ties completed. Research note 51. April 1947. Mimeo. 2 pp.

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Partial list of treating plants and pole and post yards in Montana, northern Idaho, and eastern Washington. April 1947. Mimeo. 4 pp.

Friedrich Res. Note 52 Station Paper 7

Gisborne, H. T., et al
Report of aerial bombing evaluation board. August 1947. Mimeo. 3 pp.

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Aerial bombing of forest fires. Mult. 13 pp.

Helmers, Austin E.
Direct seeding experiments in the Inland Empire. Northwest Science XXI(2):84-88. May 1947.

Holmes, P. N.
1945 lumber production in the northern rocky mountain region. Research note 49. March 1947.

_____ and LeBarron, R. K.
Montana Christmas tree production highest on record. Research note 50. March 1947.

Mosley, Neil W. and Adams, Lowell
The effects on mammals of DDT used in experimental efforts to control bark beetles in northwestern Wyoming. September 1947. Mimeo. 6 pp.

Hutchison, S. B.
The design of analytical forest survey reports. September 1947. Ditto, 19 pp.

Kemp, P. D.
Changes in Benewah County forest statistics. Station paper 6. July 1947.

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Use of volume tables. September 1947. Ditto, 5 pp.

LeBarron, Russell K.
A program for forest management research in western Montana. Proc. Mont. Acad. Sciences, vols. 5 and 6. Processed.

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The social implications of forest management research. Northwest Science, XXI(3):119-121. August 1947.

Mueller, Lincoln A.
Suitability of Engelmann spruce, western white pine, ponderosa pine, and western larch for the manufacture of veneer and plywood. May 1947. Typed, 19 pp. Illus.

Peterson, Roald A.
Book review: Life histories of North American jays, crows, and titmice. Scientific Monthly 65(1): July 1947.

Roe, A. L.
The growth rate of selectively cut ponderosa pine in western Montana. Research note 55. September 1947.

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What is the right cutting cycle for ponderosa pine? Research note 57. December 1947. Mimeo.

Wellner, C. A. and Roe, A. L.
Management practices for Christmas tree production. Station paper 9. November 1947.

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Pole blight - a new disease of western white pine. Station paper 8. November 1947.

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Forest protection in the silviculture of western white pine forests. Northwest Science XXI(3):109-12. August 1947.

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Marking instructions for the white pine type in the northern rocky mountain region. May 1947. Processed, 14 pp.

2. Departmental Publications Planned F.Y. 1948

Harris, Grant A.
When to start grazing summer cattle ranges in southwestern Montana. Approx. 80 typed pages.

Hurtt, Leon C.
Management of short-grass cattle ranges to minimize drought effects. Approx. 50 typed pages.

Schopmeyer, C. S. and Helmers, A. E.
Seeding as a means of reforestation in the northern rocky mountains. U.S.D.A. circular.

Woolfolk, E. J.
Stocking northern great plains sheep ranges for sustained production. Approx. 60 typed pages.

3. Departmental Publications Planned F.Y. 1949

Friedrich, C. Allan
Promising forage species for reseeding central Montana range lands. Approx. 40 typed pages.

Holscher, C. E., et al
Conservative forage utilization - key to efficient cattle production on the northern great plains ranges. Approx. 125 typed pages.

Kemp, P.D., Hutchison, S.B., and Dickerman, M. B.
Forest resources of western Montana. Approx. 50-75 pages.

Reed, M.J., Peterson, R.A., Hurtt, L.C., and Woolfolk, E.J.
Response of vegetation, soil, and cattle on northern great plains range to three rates of stocking. Approx. 150 typed pages.

4. Other Publications Planned for Release in 1948

Adams, Lowell
The effects of DDT on wildlife in the northern rockies. To be submitted to Outdoor Montana.

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The browsing of ponderosa pine reproduction by deer on the Fisher River, Montana. Research note.

Anderson, I. V.
Trends in the utilization of pole species and their effect on forest management. Journal of Forestry.

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Pole timber supplies of the northern and four western states and a look at production problems. Proc. American Wood Preservers Assoc.

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Ponderosa pine tree grades and how to use them for quality appraisal. Station paper.

Barrows, J. S.
Will aerial bombing become a practical means of fire control? Fire Control Notes.

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Analysis of fire behavior and control in the northern rockies. Station paper.

Boe, K. N.
Natural regeneration on cut-over ponderosa pine lands in western Montana.

Brown, C. W. and Hodge, W. C.
Forest resource statistics, northeast Montana. Station paper.

Dickerman, M. B.
Christmas tree shipments drop 24 percent. Research note 59. January 1948. Mimeo.

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Forestry in postwar Italy. Journal of Forestry.

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Volume, location, and character of pole production. Wood Products Clinic. April 1948.

Finch, Thomas L.
Effect of bark growth in measurement of periodic growth of individual trees. Research note no. 60. March 1948.

Gisborne, H. T.
Calculating precipitation probabilities. Journal Forestry. The Timberman

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The problem and probabilities of the critical fire season. Journal Forestry.

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An operational analysis of fire control. Fire Control Notes.

Helmers, Austin E.
Early results from thinning seed spots. Research Note.

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Results of girdling. Research Note.

Hosley, Neil W., Manavan, Mitchell C., Adams, Lowell and Johnson, David W.
The effects on fish, birds and mammals of DDT used in the control of forest insects in Idaho and Wyoming. To be submitted to Journal of Wildlife Management.

Hurtt, L. C.
The problem of the plains. American Hereford Journal. January 1948.

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Range management for greater stability of northern great plains. U.S.D.A. Yearbook 1948.

Hutchison, S. B. and Matthews, D. M.
Development of Forest Service policy for management of white pine under the handicap of blister rust in the Inland Empire. Station paper.

Kemp, P. D.
Tables for approximately volume growth of individual trees. Station paper 11, March 1948.

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Forest resource statistics, Northeast Washington. Station paper.

LeBarron, Russell K.
Cutting lodgepole pine in the northern rocky mountains. To be submitted to Journal of Forestry.

Mueller, L. A.
Veneer and plywood from northern rocky mountain woods. Station paper.

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A resume of recent pulping tests of lodgepole pine. Research note.

Pissot, H. J. and Peffer, E. F.
Forest resource statistics, Cascade County, Montana. Station paper 12. April 1948.

Roe, A. L.
Growth of a selectively cut stand of ponderosa pine in western Montana. To be published in Proc. of the Montana Academy of Sciences.

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Results of selective cutting in the larch-fir type. Research note.

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Results of past cuttings in ponderosa pine stands in western Montana. Station paper.

Wellner, C. A.
Stand improvement guide for northern rocky mountains.

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New disease threatens western white pine stands. Submitted to Journal Forestry.

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Light intensity related to stand density in mature stands of the western white pine type. Submitted to Journal of Forestry.

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Preliminary results of partial cuttings in western white pine stands. Research note.

PERSONNEL OF STATION - December 31, 1947

OFFICE OF DIRECTOR

Chas. L. Tebbe	Director
Norman L. Henry	Administrative Assistant
S. Dagmar Nelson	Clerk

DIVISION OF FIRE RESEARCH

Harry T. Gisborne (chief)	Forester
Jack S. Barrows	Forester
Mary C. Bowler	Clerk-stenographer
Albert W. Peiffer	Forestry Aid (Research)

DIVISION OF FOREST MANAGEMENT RESEARCH

Russell K. LeBarron (chief)	Silviculturist
Charles A. Wellner	Silviculturist
Austin E. Helmers	Silviculturist
Grace E. Dygert	Clerk-stenographer

FOREST UTILIZATION SERVICE

Irvin V. Anderson (chief)	Forester
Lincoln A. Mueller	Forester
Marie E. Bouchard	Clerk-stenographer

DIVISION OF RANGE RESEARCH

Leon C. Hurtt (chief)	Range Examiner
Laurence R. Short	Range Conservationist (Research)
C. Allan Friedrich	Range Conservationist (Research)
Roald A. Peterson	Range Conservationist (Research)
Grant A. Harris	Range Conservationist (Research)
Merton J. Reed	Range Conservationist (Research)
Anthony B. Evanko	Range Conservationist (Research)
Eldon E. Meik	Range Conservationist (Research)
Dorothy F. Truxler	Clerk-stenographer

DIVISION OF FOREST ECONOMICS

Murlyn B. Dickerman (chief)	Forest Economist
S. Blair Hutchison	Forest Economist
Paul D. Kemp	Forester
Clarence W. Brown	Forester
Elwyn F. Peffer	Forester
William C. Hodge	Forester
Henry J. Pissot	Forestry Aid (Research)
Thomas L. Finch	Forestry Aid (Research)
Gordon A. Hutton	Forestry Aid (Research)
Melvin E. Metcalf	Forestry Aid (Research)
Monica E. Hobe	Clerk-stenographer

WESTERN MONTANA WORK CENTER

Russell K. LeBarron (chief)	Silviculturist
Arthur L. Roe	Silviculturist
Ben M. Huey	Forester
Kenneth N. Boe	Forester
Anthony E. Squillace	Forester
Marvin W. Foiles	Forestry Aid (Research)
DeWilton C. Smith	Forestry Aid (Research)
Robert L. Conn	Forestry Aid (Research)
Elmer A. Heisel, Jr.	Agricultural Aid
Marie Van Loon	Clerk-stenographer

DIVISION OF FOREST WILDLIFE INVESTIGATIONS
(In cooperation with Fish and Wildlife Service)

Lowell Adams	Biologist

FIELD STATIONS

Deception Creek Experimental Forest	Austin E. Helmers
Priest River Experimental Forest	Albert W. Peiffer
Miles City Experimental Range	Laurence R. Short
Vigilante Experimental Range	Grant A. Harris